554

SCIENTIFIC LIBRARY

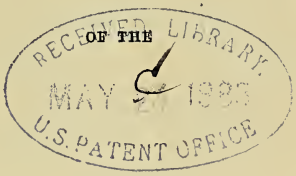
UNITED STATES PATENT OFFICE

CASE _____ SHELF _____

GOVERNMENT PRINTING OFFICE 11—8625

MINUTES OF PROCEEDINGS

OF THE



ROYAL ARTILLERY INSTITUTION.

VOLUME XI.

45.001

WOOLWICH:
PRINTED AT THE ROYAL ARTILLERY INSTITUTION.

M.DCCC.LXXXI.

UF
1
R81

CONTENTS.

PAGE

Shooting Properties of the Small-Arms in use in Europe. (Illustrated by Tables from the "Ballistik der Handfeuerwaffen in Tabellen.") By Lieut. A. Indra, Austrian Artillery. Translated by Bt.-Major T. Fraser, R.E. 1

A telescopic Sight for Field Guns. By Lieut. D. F. Downing, R.A. 20

The Austrian Mountain Artillery in the Campaign in Bosnia, 1878. By Lieut. J. M. Grierson, R.A. 24

Mountain Guns for Indian Frontier Service. By Capt. E. Walsh, R.A. 32

The Weldon Range-Finder. By Major J. B. Richardson, R.A. 41

Further Notes on the Office Work of a Garrison Battery. By Major R. Phipps, R.A. 47

Explanatory Notes on Professor A. G. Greenhill's Paper "On the Rotation Required for the Stability of an Elongated Projectile." By Captain J. P. Cundill, R.A. 103

Appendix A of Proposed Limber System for Field Artillery. By Major W. B. E. Ellis, R.A. 113

Note on the Ammunition Equipment of Artillery in the Field. By Colonel W. J. Williams, C.B., R.A. 118

On the Rotation Required for the Stability of an Elongated Projectile. (An Elementary Demonstration.) By A. G. Greenhill, M.A., Professor of Mathematics to the Advanced Class of Artillery Officers 119

On the Derivation, or Drift, of Elongated Rifled Projectiles. By A. G. Greenhill, M.A., Professor of Mathematics to the Advanced Class of Artillery Officers 124

On the Motion of a Projectile in a Resisting Medium. By A. G. Greenhill, M.A., Professor of Mathematics to the Advanced Class of Artillery Officers 131

The Armament of Shere Ali's Army. (Extracted from an Indian Newspaper.) Communicated by Lt -Col. Sidney Parry, R.H.A. 140

An Account of the March of Lord Chelmsford's Column to Ulundi, in June and July, 1879. By Lt.-Col. J. T. B. Brown, C.B., R.A. 146

The French Field Guns. (Accompanied by a Table of the Field Guns of the principal European Powers.) Extracted from "The Field Artillery of Austria, Germany, Russia, Italy, and France," by Captain Beckerhinn... 159

Short Notes on the 13-pr. M.L. Gun. By Major S. J. Nicholson, R.H.A.....163

Recent Experiments regarding the Bursting of Heavy Guns. (A Lecture delivered at the R.A. Institution, on 18th March, 1880, by Captain C. Orde Browne, late Royal Artillery) 177

Appendix B of Proposed Limber System for Field Artillery. By Major W. B. E. Ellis, R.A. 199

PAGE

Field Range-Finding. By Lieut. E. G. Edwards, R.A. 202

Range-finders. By Lieut. E. G. Edwards, R.A. 209

The Attack of Entrenchments by Field Artillery. By Major W. Kemmis, R.A. (The R.A. Institution Gold Medal Prize Essay, 1880) 215

Annual Report and Abstract of Proceedings of a General Meeting of the Royal Artillery Institution, held on June 2, 1880; Colonel Tupper, R.H.A., in the Chair 234

Journal of the March of 5/11 Heavy Field, or Elephant, Battery from Morar to Kandahar. By Major C. Collingwood, R.A. 245

Professional Notes Extracted from my Diary during the South African War of 1878–9. By Lieut. F. G. Slade, R.H.A. 253

Mountain Guns in the Naga Hills, 1879–80. By Lieut. A. Mansel, R.A.... 263

Krupp's Meppen Experiments of 1879. By Capt. C. Orde Browne, late Royal Artillery. (Re-printed from the Journal of the Royal United Service Institution 271

The Russian Field Artillery in the War of 1877–78. Translated from the "Memorial de Artillería." By Capt. J. C. Dalton, R.A. 291

The Question of the Ammunition Equipment of Artillery in the Field. By Major S. J. Nicholson, R.H.A. 309

Notes on Armoured Defences. A Lecture delivered at the R.A. Institution on 29th April, 1880. By Colonel Inglis, R.E. 317

Italian Percussion Fuze (1879) for Field and Mountain Guns. Translated from the "Mittheilungen über Gegenstände des Artillerie-und-Genie-Wesens. By Capt. G. C. Wynne, R.A. 343

Adoption of a Revolver for Horse and Field Artillery in Holland. Translated from the "Revue d'Artillerie," Sept. 1880. By Capt. A. E. Turner, R.H.A. 345

Letter on the Weldon Range-Finder. From Major J. B. Richardson, R.A.... 347

On the Rank, Post, and Duty of an Officer Commanding Royal Artillery in the Field. By Colonel W. J. Williams, C.B., R.H.A. 357

The Weldon Range-Finder. By Colonel A. W. Drayson, R.A., F.R.A.S. ... 363

Description of a Range-Finder proposed by Captain F. Roberts, R.A. By Lieut. H. C. Dunlop, R.A. 365

Extracts from the "Revue d'Artillerie." Translated by Capt. A. E. Turner, R.H.A. 371

Subaltern Officers. By Lieut. A. M. Murray, R.H.A. 373

The Organization and Employment of Garrison Artillery. Translated by a Member of the R.A. Institution 389

Zaimukht Expedition. By Captain G. T. Carré, R.A. 399

Notes on the Laying of Guns by means of a Telescope. Translated from the French, by Captain E. Walsh, R.A. 403

Description of a Special Ammunition Box. By Captain A. F. Fletcher, R.A. 411

Précis of Contents of the "Organ," &c., Part 4, Vol. XXI. Translated by Lieut. J. M. Grierson, R.A. 413

Extracts from the "Revue d'Artillerie," November, 1880. Translated by Captain A. E. Turner, R.H.A. 416

PAGE

Contents of the "Mittheilungen," &c., 10th and 11th Parts, 1880. Translated by Captain G. C. Wynne, R.A. 418

Note on the Elementary Squad Drill in the Swiss Army. By Captain C. S. Graham, R.A. 420

Trajectories of the 9-pr., 13-pr., and 16-pr. M. L. R. Guns. By Lieut. P. A. MacMahon, R.A. 421

Infantry Fire in Fortress Warfare. Translated by Lieut. R. M. Bond, R.A. 427

German Imperial Manœuvres, 1880. By Captain A. E. Turner, R.H.A.... 429

Defence of Ekowe. By Lieut. W. N. Lloyd, R.H.A. 451

On Improved Shape for Moulding Gunpowder. By Lt.-Col. M. Tweedie, R.A. 467

Addendum to the Drill Regulations of the Foot Artillery. Berlin, 1880 469

Notes from "Report on Experiments with Armour-piercing Projectiles up to 9-inch calibre." By Captain J. P. Cundill, R.A. 477

Translations of Reports of Experiments, &c., with Armour-piercing Projectiles, carried out in Russia and Holland during the last two years. From the "Revue d'Artillerie." By Captain W. M'Clintock, R.A. 491

Dutch Trials of Competitive Projectiles. By Lieut.-Col. Le Fer Taylor, R.A. 507

Practice with the 25mm (1-in.) Nordenfelt Machine Gun, on H. Grüson's Practice Ground at Bŭchăn, on 22nd December, 1879. By Captain E. Bainbridge, R.A. 511

Description of the 1-in. Torpedo Battery Gun. By Captain E. Bainbridge, R.A. 515

Note on the Service of the Artillery at Maiwand, 27th July, 1880. By Captain N. P. Fowell, R.A. 518

Résumé of an account of Comparative Trials of the Nordenfelt Mitrailleuse and the Hotchkiss Revolver Gun carried out in England, Italy, Denmark, Russia, and France. From the "Revue d'Artillerie," February, 1881. By Captain A. E. Turner, R.H.A. 519

Austria. { Trial of a Repeating Rifle. / Use of Dynamoge. } Translated by Captain A. E. Turner, R.H.A. 522

Extracts from the Diary of a Russian Artilleryman in the Shipka Pass, 1877. From the Russian. By Lieut. J. M. Grierson, R.A. 523

The Artillery and Engineer Journal. From the Italian. By Captain A. E. Turner, R.H.A. 538

On Fixing Positions by the More Simple Astronomical Observations, for the use of R.A. Officers engaged in Exploration. By Major E. S. Gordon, R.A. 539

The Equipment of Field Artillery. (The R.A. Institution Gold Medal Prize Essay, 1881). By Captain J. R. J. Jocelyn, R.A. 549

Abstract of the Proceedings of the Forty-Fourth Annual General Meeting of the Royal Artillery Institution 575

On the Motion of a Projectile in a Resisting Medium. By A. G. Greenhill, M.A., Professor of Mathematics to the Advanced Class of Artillery Officers 589

Description of a Veterinary Field Companion. By Lieut. J. Hotham, R.H.A. 599

Extracts from the "Russian Small Arm Magazine," No. 3, 1880. By Lieut. J. Wolfe Murray, R.A. 603

PAGE

Observations by a Subaltern on a paper entitled "Subaltern Officers." By Lieut. R. F. Johnson, R.A. 605

Complete List of Personal and Official Equipment for Special Service. By Colonel F. E. Cox, R.E. 613

List of Necessaries and Luxuries for Campaigning and Exploring. By Captain T. Fraser, R.E. 619

The Effect of Shell on Mud Walls. Contributed by Brig.-General Denis de-Vitre, R.A. 623

Remarks on the Weldon Range Finder. By Lieut. A. H. Russell, U.S.A. ... 631

Extracts from the Russian Artillery Journal, November, 1880. Translated by Lieut. J. M. Grierson, R.A. 637

Tactics of the Three Arms. By Captain T. J. Roch, R.A. 639

Extracts from the "Giornale di Artiglieria e Genio," January, 1881. Translated by Captain A. E. Turner, R.H.A. 643

Extracts from the "Revue d'Artillerie," January, 1881. Translated by Captain A. E. Turner, R.H.A. 645

Extracts from the "Organ der Militar Wissenschaftlichen-Vereine. Translated by Lieut. J. M. Grierson, R.A. 649

Notes on the Austrian Field Artillery Service Practice, as introduced in 1872. Communicated by Colonel W. H. Goodenough, R.A. 653

Note on the Prussian Mode of Indirect Laying of Guns. Contributed by Major Van Straubenzee, R.A. 660

Extracts from the "Memorial de Artilleria." Translated by Captain J. C. Dalton, R.A. 661

The French in Africa, from the Deutsche Heeres-Zeitung, 20th August, 1881. By Capt. T. J. Roch, R.A. 667

Experiments carried out by Herr Krupp at Meppen. Communicated by Major C. H. Fairfax Ellis, R.A. 669

Short description of Small Stone-wall Fort thrown up for two 7-pr. R. M. L. Jointed Guns of No. 1 Battery, 8th Brigade (Mountain Battery), at Camp Thull, during the Afghan War of 1879–80. By Lieut. T. V. W. Phillips, R.A. 672

The Training of "Pointeurs" for Artillery. From the French. By Lieut. H. C. Dunlop, R.A. 673

The Battles of Laing's Nek and Ingogo, with Brief Notes on the 9-pr. of 6 cwt., and General Equipment. By Lieut. C. S. B. Parsons, R.H.A. 677

Index 691

SHOOTING PROPERTIES OF THE SMALL-ARMS IN USE IN EUROPE.

(*Illustrated by Tables from the "Ballistik der Handfeuerwaffen in Tabellen."*)

BY

LIEUT. A. INDRA, AUSTRIAN ARTILLERY.

TRANSLATED BY

Bt.-Major T. FRASER, R.E.

In a complete theory of the motion of projectiles one must take into consideration influences of all kinds which pertain to the arm, to the projectile, or to the resistance of the air; but a certain number of these influences entirely escape our methods of observation, and can only be expressed by more or less arbitrary hypotheses, which in a measure prejudge their importance, while singularly complicating calculations.

In practice, on the contrary, one can, without disadvantage, confine oneself to the consideration and employment of none but the essential influences. In such case calculations become sufficiently simple. For instance, to compare the shooting properties of modern small-arms one may confine the consideration to two main variables: the *powder charge—i.e.*, the *muzzle velocity* given to the projectile—and the *mass* of the latter, expressed for purposes of calculation by the weight for each unit of area in a section at right angles to its axis.*

The resistance of the air is a function of the muzzle velocity and of the latter quantity, which we shall call *density of right section*, while we propose to give the name *proportion of charge* to the ratio of the weights of projectile and powder.

To get flatness of trajectory, such as is now-a-days required, a high muzzle velocity is required; but this has the disadvantage of developing a considerable air resistance, the influence of which is all the more perceptible in proportion to the small size and weight of musket bullets.

As, on the other hand, the density of their *right section* is small, the slightest variation therein leads to very marked variations in the trajectory. The comparative tables that end this sketch show this very distinctly.

Formulæ once established permit of the ready calculation of tables, with the aid of which the influence of each of the two independent variables—namely, muzzle velocity and density of section can be considered. This method has, over the analytical one, the advantage of being within the reach of all, and of lending itself to many and easy applications.

To construct these tables, take a projectile fired with an elevation of ϕ degrees and a muzzle velocity V. The time t for describing, in

---

* Usually expressed as $\frac{d^2}{w}$.

vacuo, the parabolic arc $AB'C'D'$ (Fig. 1), of which the horizontal projection is x_p, is given by the formula

$$t = \frac{x_p}{V \cos \phi}.$$

During the same time t, the bullet will, in air, have described a trajectory $ABCD$, the projection of which, x, will be less than x_p. We then have

$$t = \frac{x}{V \cos \phi} \left(\frac{x_a}{x_a - x} \right)^m. \quad \ldots\ldots\ldots\

$x_a = \infty$ or when $m = 0$; the quantity x_a is thus small in proportion as the effect of the air resistance is great, and consequently as m itself is proportionally great.

It is conceivable also that, given the equation of the trajectory, the parametres x_a and m are obtainable by means of more or less long and complicated calculations with the practical data got from two series of rounds corresponding to two different distances, by a method similar to that indicated in *Graphic Ballistics*.*

Take, for example, the Werndl, converted for the use of the strengthened cartridge of 1877. The angles of elevation for 600 and 1600 paces (500 and 1333 yds.) are respectively

$$\phi_1 = 1^\circ\ 1'\ 58'', \text{ and } \phi_2 = 4^\circ\ 37'\ 58''.$$

The mean values are then calculated to be

$$x_a = 1251^m, \text{ and } m = 1{\cdot}46;$$

quantities which may be taken as constant when the range does not exceed 1200 paces. For greater distances x_a and m must be recalculated with suitably selected experimental data.

This settled, the tables were calculated by means of the following formulæ:—

(*a*) *Ordinates of the trajectory:*

$$y = x \tan \phi - \frac{g x^2}{2 V^2 \cos^2 \phi} \left(\frac{x_a}{x_a - x} \right)^m. \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

(*b*) *Angle of elevation for range X:*

$$\sin 2\phi = \frac{gX}{V^2} \left(\frac{x_a}{x_a - X} \right)^m. \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

(*c*) *Angle of drop:*

$$\tan \theta = -\tan \phi \, \frac{x_a + (m-1)X}{x_a - X}. \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

(*d*) *Remaining velocity:*

$$v = V \frac{\sin \phi}{\sin \theta} \left(\frac{x_a - X}{x_a} \right)^m. \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

(*f*) *Dangerous zone,* to catch the height (h) of a man—viz. 6 ft.:

$$z = \frac{X}{2} - \sqrt{\frac{X^2}{4} - \frac{hX}{\tan \theta}}. \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

---

* See "Revue d'Artillerie," XI., Feb. 1878.

(*g*) *Dangerous trajectory.*—The angle of elevation giving a trajectory which catches a height of 6 ft. throughout is got as follows :—

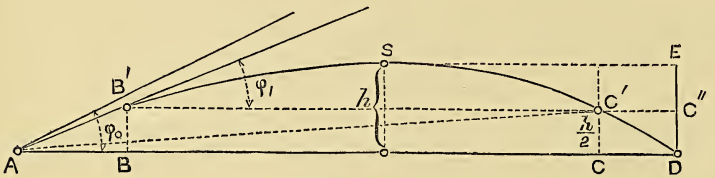
The trajectory which nowhere rises more than 6 ft. above the level is always one of short range; one may therefore substitute a simple parabola (Fig. 2) for it, of which the highest ordinate h is given by the formula

$$h = \frac{V^2}{2g} \sin^2 \phi ;$$

hence

$$\sin \phi = \frac{\sqrt{2gh}}{V}. \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Fig. 2.



To calculate the range which is all dangerous, assume the firer holds his arm at B' at a given height above the ground, which we will consider horizontal, and aims at the enemy's middle at C'; if $B'C'$ be assumed horizontal, no part of the trajectory should rise more than 3 ft. above it, and if in (7) we make $h = 3$ ft.,

$$\sin \phi_1 = \frac{\sqrt{2 \times 9{\cdot}81 \times 0{\cdot}9}}{V} = \frac{4{\cdot}202}{V};$$

V being expressed in mètres; and by means of a table of elevations, the range BC due to the angle ϕ_1 is readily obtainable by interpolation.

The total range AD due to the angle ϕ_0, calculated with $h = 6$ ft., is similarly deduced. In this case we have

$$\sin \phi_0 = \frac{\sqrt{2 \times 9{\cdot}81 \times 1{\cdot}8}}{V} = \frac{5{\cdot}9427}{V}.$$

BD, the real space swept, can then be found approximately by means of AD; for

$$BD = BC + CD.$$

If it is seen that $CD = AB$, it follows that

$$AD = 2CD + BC,$$

$$CD = \frac{AD - BC}{2};$$

and as $BC = B'C'$, we have

$$BD = B'C' + \frac{AD - B'C'}{2}.$$

The quantity BD is that given in the tables; it gives the greatest range of trajectory dangerous throughout.

(*h*) *Time of flight.*—As pointed out at the commencement, the time of flight of a projectile to accomplish, in the air, the horizontal range defined by the elevation ϕ and the muzzle velocity V is the same as that required in vacuo to accomplish the parabola determined by the same conditions.

$$T = \frac{2V}{g} \sin \phi. \quad \text{.....} \quad \text{.....} \quad \text{..(8)}$$

On this point it is worthy of remark that it may be interesting, above all at the long ranges, to know the time of flight. Such data have a practical importance in firing against moveable marks with a known rate of motion.

II.

Examination of the Comparative Tables.

The arms of the different powers of Europe are in the present day based on the same general principles. It may then be granted that their relative shooting properties vary exclusively on account of differences between the weights of the bullets and those of the powder charges—that is, between the sectional density on the one part and the muzzle velocity on the other.

For the closer study of the influence of these two elements, we may take as extreme types the Austrian Werndl, converted for the strengthened cartridge (that of 1877), and the English Martini-Henry.

The characteristic of the first is great muzzle velocity with a relatively feeble sectional density; that of the second, a great sectional density with low muzzle velocity. All the other systems take place between these, in which the following considerations, got from the comparative tables, illustrate specially their characteristic properties.

Angle of Elevation ϕ.—In comparing the firing angles of the different arms for the same distance, it appears, at starting, that the increase of muzzle velocity takes the form of a reduction in the angle of elevation. Thus, at 100 paces the angle of elevation of the Austrian gun is but

7′ 11″, while that of the English one reaches 8′ 49″, which is the highest.

When the velocities differ but little, the influence of sectional density is early felt, the angle of elevation increasing less in proportion as the latter is great. Thus the curve of elevation of the converted Austrian rifle cuts that of the French and Russian at about 100 paces,* the Prussian exactly at 600, and that of the English between 900 and 1000 paces; lastly, the curves of the English and French arms only intersect between 1000 and 1200 paces.

As regards angles of elevation, the two last systems may be taken as the most favorable—the French for mean and the English for long ranges.

In the tables a system Y has been introduced, which, for each element, surpasses all the others. The system is purely ideal, but the shooting conditions on which it is based must be adopted in every new type. Thanks to a reduction of calibre to 10 millimètres (0·3937 ins.), and to a lengthening of the bullet to $2\frac{3}{4}$ calibres (bullet 370·56 grs., charge 76·2 grs.), it combines the muzzle velocity of the Austrian with the sectional density of the English arm. These conditions are not in any way extreme, and would of necessity be adopted by any state now about to re-arm its infantry.

Angle of Drop θ.—The angle of drop gives a preliminary idea, generally sufficient, of the form of the path near the mark; and it is plain that the smaller the angle of drop for any one distance, and consequently the more sweeping the path, the more serviceable is the arm. Here, again, thanks to the great density of the section of its bullet, the English arm takes precedence, and at 2400 paces (2000 yds.) has the same angle of drop as the converted Austrian arm at about 1900 (1590 yds.) The diagrams of the angles of drop of the different arms also intersect, but the points of intersection are not coincident with those of the angles of elevation; because, for a given distance, the difference between the angles of elevation and drop is less in proportion as the sectional density is great and the muzzle velocity is small. The double action of these two elements places the point of intersection of the curve of the English rifle with that of the others at between 400 and 500 paces (333 and 414 yds.) for the Austrian, between 600 and 800 paces (500 and 666 yds.) for the French, and between 300 and 400 paces (250 and 330 yds.) for the Italian, and so on.

From this it follows that at certain distances the angle of drop for a given arm may be less than for another, although the angle of elevation for the former may be greater than for the latter. This fact is noticeable for the whole interval between the point of intersection of the curves of the angles of drop and that of the curves of the angles of elevation of the systems under consideration—for instance, between about 700 and 1200 paces (583 and 1000 yds.) for the English and French arms.

---

* The pace $= \frac{5}{6}$ of a yard $= \frac{3}{4}$ of a mètre.

Remaining Velocity.—The remaining velocities in the tables are calculated by an approximate formula, which gives values a little in excess of the truth. It may, however, be stated that at long ranges the English rifle has a *marked superiority.*

The almost absolute identity of remaining velocities with the English and the ideal systems at about 2400 paces (2000 yds.) confirms this nearly self-evident principle of theory—that the remaining velocity at long ranges depends less on the muzzle velocity or the form of the head of the bullet than on the sectional density of the latter. It is, however, also to be understood that the first condition for securing long range is to start with a relatively high muzzle velocity.

The latter appears all the more imperative, if it be considered that for convenience of shooting it is necessary, at short ranges, to do without sights, or at all events to use low sights, and consequently low angles of elevation. In this double aspect, system Y appears to show the progress that might be looked for in a new arm.

The Dangerous Zone.—It is seen at a glance that to give the greatest extension to the dangerous zone it is right to have a heavy bullet, little influenced by the resistance of the air, and one which, in consequence, describes a flatter trajectory towards the end of its course.

The previous remarks relative to the angle of drop are here applicable, since the length of the dangerous zone varies directly with the magnitude of this angle.

Exclusive of the system Y, the dangerous zones of which are notably superior to those of all the others, the English, French, Russian, Prussian, Spanish, and converted Austrian arms all give the same maximum range swept throughout. The differences between their dangerous zones at other distances towards the end of the trajectory are unimportant. The Italian and Swiss Vetterli arms are somewhat inferior to them.

Time of Flight.—Besides the advantage there may be in introducing this datum into the tables with a view to firing against a moving object, it is worth remark that it may serve to indicate whether the arm is of a nature favorable to long-range fire.

In glancing over the tables, it appears that for short ranges the times vary but slightly with nearly the same muzzle velocities;* the differences in general being confined to hundredths of a second.

At long ranges, on the other hand, the differences are very pronounced in favor of arms with bullets of the greatest sectional density. At 2400 paces (2000 yds.) they amount to 3 and even 5 secs.

Table of Ordinates.—The table of ordinates refers only to two main

---

* The muzzle velocities given by writers on European small-arms vary considerably; because actual experiments lead to unavoidable irregularities, due to different kinds of powder. As there is not, in this theoretical paper, space to take this into account, the ratio of the weight of the charge to that of the bullet has been preferred as the basis.

types. The first (type A), with a calibre of 11^{mm} (0·433 ins.), a charge of 5 grammes (85 grs.) and 5·2 grammes, and a bullet of 24 to 25 grammes (370 to 385 grs.), represents the converted Austrian, the Prussian, the French, the Russian, and Spanish arms; the other (type B) represents the English.

To find in the table the ordinate, or vertical height, which, for instance, corresponds to an abcissa, or horizontal distance, of 500 paces, the total range being 1000 paces; according as type A or B be in question, the range of 1000 paces is taken in the top or bottom horizontal column, and the abcissa (500 paces) in the vertical column on the right or left. Where the vertical column containing 1000 meets the horizontal column containing 500, the ordinate 9·017 mètres for type A and 8·253 mètres for type B is found.

The table gives a ready means of considering the general properties of the trajectory between the limits considered—namely, 100 to 2400 paces—and of estimating comparatively certain advantages and defects inherent in each of the two types. It also contains, in a commodious form, the data required for solving different problems in shooting, and suffices approximately for estimating the depth of dangerous zone when the mark has a certain height, &c.

To compare the path of the type A with that of the Martini, the maximum ordinates (printed in large type) may be taken as characteristic.

The table, then, shows that for ranges lower than 600 paces (500 yds.), the trajectory of the English arm is higher at its vertex, or highest point, than that of type A; that the maximum ordinates are equal with the two types for ranges between 600 and 800 paces (500 and 600 yds.), from which point they rapidly diverge; so that for the range of 2400 paces (2000 yds.) the maximum height of the Martini-Henry trajectory only amounts to 74·29 mètres (245 ft.), while it rises to 102·86 mètres (337 ft.) for the other type. These ordinates are, moreover, at 1300 paces from the firing point for the first, and 1400 paces for the second. The English arm has therefore a smaller drop and a deeper dangerous zone.

Without carrying these deductions further, we will confine ourselves to pointing out how to use the table to solve the problem of fire against a concealed object—a problem that up to the present has only been dealt with practically to a small extent, but which, if intelligently handled, would give a new accession of power to infantry.

It appears useful to be in a position to calculate the necessary data for the execution of this kind of fire; although it may be truly said that its success will mainly depend on the care with which the troops have been practised in it, and still more on the intelligence and aptitude of their leader.

The problem may be expressed as follows:—Given a mark at a known distance, concealed from the firing point by an obstacle before it, to find such a visible intermediate point that by aiming at it with a suitably selected sight, the real mark, placed behind the covering object, may be struck.

Let *D* (Fig. 2) be a mark of the same height as *A* (the firing

point), and CC' a covering mass, before the mark, of a known height and at a known distance CD.

The figure shows that CC' and CD are the co-ordinates, with reference to the mark, of a point C' of a certain trajectory, which is consequently easy to find in the tables. If this trajectory happen to be that which gives the desired range AD, all one has to do is to take the sight for this distance, which corresponds to the angle of elevation ϕ_0; the point to aim at C being chosen on the line AD.

Equally, the sight for the distance AC answering to the angle of elevation ϕ_1 may be taken, and the point C'—*i.e.*, the top of the obstacle—aimed at.

For example, we will suppose the mark to be at a distance $AD = 1000$ paces, and to be hidden by a mask $3\frac{1}{2}$ mètres high, placed about 100 paces on our side of it. These data are sufficiently near those found in the table for the range of 1000 paces; one should therefore take, either the sight for 1000 paces and aim at the base, or that for 900 paces and aim at the top of the covering mass.

When, on the contrary, the co-ordinates CC' and CD are not contained in the trajectory which gives the range, the only case that need be considered is that in which the distance of the covering mass from the mark is too short to allow the shots to strike the latter; all the shots that pass over the mask pass equally over the mark. In such case the trajectory containing these points is that of a longer range, and in order to strike the mark we must go back for a suitable distance, which can easily be found from the table.

For example, if the mark remain at 1000 paces, and the mask, 100 yds. short of it, be 5 mètres high, the former cannot be hit; but the table shows that, at 1200 paces, the ordinate at 100 paces short is about 5 mètres high. In order, therefore, to produce an effect, the shooting party must be retired 200 paces, and must shoot with the sight for 1200 paces at the foot, or with that for 1100 paces at the top of the mask.

The drop of musketry is such that, when exposed to an intelligent use of indirect fire, no troops could long retain a close formation; and even in open formation cover will no longer furnish them with efficient protection, unless it is very close and of sufficient height.

III.

General Observations.

The weight of the cartridge, like that of the arm, is limited by certain considerations. The necessity for permitting each man to carry enough rounds for himself, makes it obligatory for the cartridge not to exceed a total weight of 30 to 40 grammes (463 to 617 grs.) The best ratio consists in taking for the projectile and the charge weights respectively equal to 25 and 5 grammes (385 and 77 grs.)

It results from this consideration that in designing an arm it is especially necessary to give to the projectile a suitable density per unit of right section.

This density plainly increases with the length of the bullet, which with an arm of large calibre cannot even reach $2\frac{1}{2}$ calibres without largely exceeding the permissible weight; it is therefore impossible, in this case, to obtain a sufficient density of section. On the contrary, if the projectile be not only lengthened but the calibre be correspondingly reduced, it is easy to go as far as $2\frac{3}{4}$ or 3 calibres, the calibre varying from 10 to 9 millimèters (0·3937 to 0·303 ins.) As shown by the system Y, these conditions, without exceeding the admissible limit of weight, are very favourable to shooting. Were it wished to convert the existing arms of 0·43-in. bore by lengthening the bullet to $2\frac{3}{4}$ calibres, to make it more fit for long ranges, the weight of the bullet would rise to about 32 grammes (494 grs.), or 0·3252 grammes per unit of section, and the large charge of 5 grammes (75 grs.) would only give the relatively low muzzle velocity of about 380 to 390 mètres (1246 to 1279 ft.) The result would be that, while the conditions would be good for short ranges, for long ranges slightly diminished angles of fire and somewhat increased dangerous zones would be obtained. But the weight of 32 grammes is too great, and it would appear better to do with a somewhat lower sectional density without attempting a more exact adjustment of the different elements of the problem.

The future of small-arms will, then, be marked by a further reduction of bore; in order to get greater sectional density in the projectile, while adhering to the present weight, which cannot be exceeded without reducing the muzzle velocity which is necessary to secure a flat trajectory at the firing point. In the English rifle, for instance, a charge of 85 grains only gives a muzzle velocity of 1305 ft.* to a bullet of 480 grs.

---

* As a matter of fact, the observed muzzle velocity of the Martini-Henry is 1353 f.s.—T. F.

It is therefore necessary to fix a certain relation between the weight of the bullet and the muzzle velocity, or the charge—a relation which is practically expressed by the ratio between the weights of the charge and projectile. Experience has shown that the most suitable value for this ratio is 1 to 4 or 1 to 5; and this, no doubt, will be maintained in future. The muzzle velocities due to this exceed 1312 ft. a second, and give a trajectory of satisfactory flatness at the firing point.

To sum up. In order to design an arm fit to shoot well at all ranges, its bullet must, at the same time, have a sufficient density of section and a high muzzle velocity, in order to obtain the flattest possible trajectory in all respects.

TABLE I.—*Principal Descriptive Data about the Small-arms in use.*

A millimètre = $\frac{1}{25}$ of an in. (nearly). 1 gramme = 15·43 grs. troy (7000 to 1 lb. avoirdupois). 1 kilogramme = 2·2 lbs. avr.	Austria.*		Germany.	France.	England.	Russia.	Italy.	Spain.	Switzerland.	Converted arms.	
	Werndl regulation patterns of 1867 and 1873.	Werndl carbine, pattern of 1867 and of 1873; converted Werndl rifle of 1873, converted for special corps.	Mauser, pattern of 1871.	Gras, pattern of 1874.	Martini-Henry.	Berdan II.	Vetterli.	Remington	Vetterli repeater.	Austria. The Wanzl.	Russia. The Krnka.
Calibre .....millim.	11		11	11	11·43	10·66	10·4	11	10·4	13·9	15·24
Grooves: Number	6		4	4	heptagonal	6	4	6	4	4	4
Grooves: Form	rectangular concentric.					rectangular concentric.					
Grooves: Depth.....millim.	0·2		0·3	0·3	0·185	0·27	0·25	0·2	0·25	0·2	0·38
Grooves: Length in mètres of one complete turn ...	rifle 0·724	carbine 0·526	0·55	0·55	0·559	0·55	0·66	0·65	0·66	2·10	1·34
Mechanism: Closing	plug with axis parallel to that of barrel		bolt.		block.	bolt.		block.	bolt.	Opening Tabatière. upwards.	to left.
Mechanism: Striking.....	link-lock (flat spring).		spiral spring.					direct.	spiral spring	lock.	
Length of arm .....mètres	1·28	1·004	1·33	1·305	1·18	1·36	1·345	1·30	1·30	1·34	1·359
Weight of arm .....kils.	M1867—4·5	3·22	4·5	4·2	4·0	4·35	4·35	4·075	4·7	4·25	4·51
	M1873—4·17	3·25									
Bullet: Form	cylindro-ogival. grooved.	cylindro-ogival. smooth.	cylindro-ogival, smooth.	slightly conical, smooth.	smooth cylinder, hemispherical head.		grooved cylinder, hemispherical head.			cylindro-ogival, grooved.	do. with expanding patch.
Bullet: Length in calibres...	2·04	2·5	2·5	2·5	2·7	2·5	2·4	2·5	2·45	1·5	1·87
Bullet: Diameter ...millim.	11·3	11·0	11	10·8 / 11·0	11·43	10·8	10·8	11·4	10·8	14·3	15·2
Bullet: Weight .....grms.	20·2	24·0	25	25	31·1	24	20·4	25·1	20·4	29·7	36·87
Bullet: Sectional density ...	0·20502	0·2436	0·2493	0·2515	0·2968	0·2500	0·2245	0·2498	0·2245	0·1850	0·1840

Action of the grooves	set up.	paper wrapper, set up and compression.					expansion	compressn.	expansion.	set up.	and set up.
Charge .....grms.	Rifle 4 Carbine 2·1	5 2·6	5	5·25	5·5	5	4	5	3·75	4·38	5·07
Wgt. of the cartdg....grms.	Rifle 31·7 Carbine 29·2	42·5 "	42·9	43·8	51·5	39·3	34·5	41·4	30·5	42·3	55·04
Muzzle velocity ...mètres.	Rifle 436 Carbine 298	438 319	430	436	389	436	435	430	432	378	327
Sighted up to paces.....	Rifle 1400 Carbine 600	2100 1600	2100	2400	1900	1500	1333	1333	1333	900	800

* The rifles and carbines are being converted at the same rate to fire the strengthened cartridge of 1877.

TABLE II.—*Mean Result of Fire with Arms of 0·43-in. calibre, with a bullet of 370 to 380 grs., and a charge of 76 to 80 grs.*

Distance.	Radius of the circle containing 50 p.c. of hits.	Total dispersion.		Per-centage of hits on a target of the height of a man and representing a company column.	
		In height.	In breadth.		
paces.	ins.	mètres.	mètres.		
400	10 to 12	—	—	—	
600	14·5 " 16	—	—	—	
800	—	1·4 to 1·8	1·2 to 1·6	60 to 80	Bullets fired at planks about 1 in. thick, placed at small intervals apart, go through
1000	—	2·8 " 3·2	2·4 " 2·5	40 " 50	
1200	—	3·8 " 4·4	2·6 " 3·0	30 " 40	7 to 8 at 500 yds. 4 to 5 " 900 yds.
1400	—	6·0 " 7·0	3·6 " 4·0	20 " 30	At 2500 yds., direct hits go through a 1-in. plank.
1600	—	7·6 " 9·0	4·6 " 6·0	15 " 20	
1800	—	12·0 " 14·0	6·0 " 7·0	10 " 20	
2000	—	18·0 " 20·0	7·6 " 8·0	9 " 15	

TABLE I.—*Principal Descriptive Data about the Small-arms in use.*

A millimètre = $\frac{1}{25}$ of an in. (nearly). 1 gramme = 15·43 grs. troy (7000 to 1 lb. avordupois). 1 kilogramme = 2·2 lbs. avr.	Austria.*		Germany.	France.	England.	Russia.	Italy.	Spain.	Switzerland.	Converted arms.	
	Werndl regulation patterns of 1867 and 1873.	Werndl carbine, pattern of 1867 and of 1873; converted Werndl rifle of 1873, converted for special corps.	Mauser, pattern of 1871.	Gras, pattern of 1874.	Martini-Henry.	Berdan II.	Vetterli.	Remington	Vetterli repeater.	Austria. The Wanzl.	Russia. The Krnka.
Calibre .....millim.	11		11	11	11·43	10·66	10·4	11	10·4	13·9	15·24
Grooves: Number	6		4	4	heptagonal	6	4	6	4	4	4
Grooves: Form	rectangular concentric.							rectangular concentric.			
Grooves: Depth.....millim.	0·2		0·3	0·3	0·185	0·27	0·25	0·2	0·25	0·2	0·38
Grooves: Length in mètres of one complete turn ...	rifle 0·724	carbine 0·526	0·55	0·55	0·559	0·55	0·66	0·65	0·66	2·10	1·34
Mechanism: Closing	plug with axis parallel to that of barrel		bolt.		block.	bolt.		block.	bolt.	Opening Tabatière. upwards.	Opening Tabatière. to left.
Mechanism: Striking.....	link-lock (flat spring).		spiral spring.					direct.	spiral spring	lock.	
Length of arm .....mètres	1·28	1·004	1·33	1·305	1·18	1·36	1·345	1·30	1·30	1·34	1·359
Weight of arm .....kils. M1867—4·5	3·22		4·5	4·2	4·0	4·35	4·35	4·075	4·7	4·25	4·51
Weight of arm .....kils. M1873—4·17	3·25										
Bullet: Form	cylindro-ogival. grooved.	cylindro-ogival. smooth.	cylindro-ogival, smooth.	slightly conical, smooth.	smooth cylinder, hemispherical head.		grooved cylinder, hemispherical head.			cylindro-ogival, grooved.	do. with expanding patch.
Bullet: Length in calibres...	2·04	2·5	2·5	2·5	2·7	2·5	2·4	2·5	2·45	1·5	1·87
Bullet: Diameter ...millim.	11·3	11·0	11	10·8 / 11·0	11·43	10·8	10·8	11·4	10·8	14·3	15·2
Bullet: Weight .....grms.	20·2	24·0	25	25	31·1	24	20·4	25·1	20·4	29·7	36·87
Bullet: Sectional density ...	0·20502	0·2436	0·2493	0·2515	0·2968	0·2500	0·2245	0·2498	0·2245	0·1850	0·1840
Action of the grooves	set up.	paper wrapper, set up and compression.					set up and expansion	set up and compressn.	set up and expansion.	set up.	expansion and set up.
Charge .....grms. Rifle 4	5	5	5·25	5·5	5	4	5	3·75	4·38	5·07
Charge .....grms. Carbine 2·1	2·6										
Wgt. of the cartdg....grms. Rifle 31·7	42·5	42·9	43·8	51·5	39·3	34·5	41·4	30·5	42·3	55·04
Wgt. of the cartdg....grms. Carbine 29·2	〃										
Muzzle velocity ...mètres. Rifle 436	438	430	436	389	436	435	430	432	378	327
Muzzle velocity ...mètres. Carbine 298	319										
Sighted up to paces..... Rifle 1400	2100	2100	2400	1900	1500	1333	1333	1333	900	800
Sighted up to paces..... Carbine 600	1600										

* The rifles and carbines are being converted at the same rate to fire the strengthened cartridge of 1877.

TABLE II.—*Mean Result of Fire with Arms of 0·43-in. calibre, with a bullet of 370 to 380 grs., and a charge of 76 to 80 grs.*

Distance.	Radius of the circle containing 50 p.c. of hits.	Total dispersion.		Per-centage of hits on a target of the height of a man and representing a company column.	
		In height.	In breadth.		
paces.	ins.	mètres.	mètres.		
400	10 to 12	—	—	—	
600	14·5 〃 16	—	—	—	
800	—	1·4 to 1·8	1·2 to 1·6	60 to 80	Bullets fired at planks about 1 in. thick, placed at small intervals apart, go through
1000	—	2·8 〃 3·2	2·4 〃 2·5	40 〃 50	
1200	—	3·8 〃 4·4	2·6 〃 3·0	30 〃 40	7 to 8 at 500 yds. 4 to 5 〃 900 yds.
1400	—	6·0 〃 7·0	3·6 〃 4·0	20 〃 30	At 2500 yds., direct bits go through a 1-in. plank.
1600	—	7·6 〃 9·0	4·6 〃 6·0	15 〃 20	
1800	—	12·0 〃 14·0	6·0 〃 7·0	10 〃 20	
2000	—	18·0 〃 20·0	7·6 〃 8·0	9 〃 15	

TABLE III.—*Ballistic Data about the Small-arms in use.*

Range.	Austria. Werndl of 1873, strengthened cartridge.					Germany. Mauser of 1871.					France. Rifle of 1874.				
	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Time of flight.	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Time of flight.	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Time of flight.
paces.*	° ′ ″	° ′ ″	mètres.		seconds.	° ′ ″	° ′ ″	mètres.		seconds.	° ′ ″	° ′ ″	mètres.		seconds.
100	0 7 11	0 7 47	373·07		0·19	0 7 24	0 8 17	371·55		0·19	0 7 12	0 7 47	373·84		0·19
200	0 15 33	0 17 59	327·49		0·40	0 15 55	0 18 12	328·87		0·41	0 15 31	0 17 52	328·92		0·40
300	0 25 1	0 30 35	293·06	Dangerous range = 426.	0·65	0 25 37	0 30 51	296·5	Dangerous range = 428·75.	0·65	0 25 0	0 30 23	295·13	Dangerous range = 434·5.	0·65
400	0 36 6	0 46 18	266·27		0·94	0 36 29	0 46 5	269·54		0·93	0 35 39	0 45 18	268·89		0·92
500	0 48 20	1 4 36	245·18		1·26	0 49 36	1 3 47	248·28		1·27	0 47 31	1 3 0	247·99		1·23
600	1 1 58	1 25 54	227·92	120·0	1·61	1 1 58	1 23 56	234·0	124·0	1·58	1 0 38	1 23 18	230·98	125·0	1·57
800	1 33 29	2 17 41	201·89	65·3	2·43	1 32 32	2 12 41	209·0	68·0	2·36	1 30 43	2 12 14	207·06	68·5	2·34
1000	2 11 0	3 22 33	183·15	42·7	3·40	2 8 28	3 10 4	191·0	45·0	3·28	2 6 8	3 12 50	194·50	44·7	3·26
1200	2 54 50	4 41 15	171·14	30·0	4·54	2 49 57	4 24 55	182·2	32·0	4·33	2 47 6	4 25 36	185·32	32·0	4·32
1400	3 42 50	5 57 40	165·96	23·3	5·78	3 35 25	5 35 24	175·4	25·3	5·49	3 32 50	5 33 40	178·0	25·0	5·50
1600	4 37 23	7 34 50	162·60	18·2	7·20	4 26 15	7 3 0	169·28	20·0	6·78	4 23 30	7 1 40	172·17	18·7	6·81
1800	5 38 3	9 21 10	158·44	14·4	8·77	5 22 25	8 40 50	163·22	16·0	8·21	5 19 25	8 39 50	167·0	16·0	8·25
2000	6 45 10	11 25 0	152·53	11·9	10·50	6 24 0	10 28 40	158·18	13·3	9·77	6 21 0	10 28 30	162·2	13·3	9·83
2200	7 59 0	13 38 16	149·11	9·9	12·40	7 31 17	12 26 40	153·93	10·7	11·48	7 28 15	12 17 10	158·1	11·3	11·56
2400	9 20 0	16 3 44	146·9	8·3	14·48	8 44 30	14 34 42	150·31	9·3	13·32	8 41 35	14 25 35	154·03	9·3	13·44

* The pace = 0·75^{m} = 2·5 ft.

TABLE III. (*continued*).—*Ballistic Data about the Small-arms in use.*

Range.	England. Martini-Henry rifle.					Russia. Berdan rifle II.					Italy. Vetterli rifle.				
	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Time of flight.	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Time of flight.	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Time of flight.
paces.*	° ′ ″	° ′ ″	mètres.		seconds.	° ′ ″	° ′ ″	mètres.		seconds.	° ′ ″	° ′ ″	mètres.		seconds.
100	0 8 49	0 9 2	370·34		0·20	0 7 12	0 7 46	375·52		0·186	0 7 19	0 7 58	367.57		0·19
200	0 18 33	0 20 22	322·37		0·43	0 15 32	0 17 49	331·59		0·40	0 15 55	0 18 34	319·79		0·41
300	0 29 52	0 34 3	299·2		0·69	0 25 2	0 30 16	298·35		0·65	0 25 52	0 32 0	284·38		0·67
400	0 40 44	0 47 59	280·35	Dangerous range = 430·9.	0·94	0 35 44	0 45 12	272·47	Dangerous range = 426.	0·92	0 37 12	0 48 22	257·22	Dangerous range = 420·5.	0·96
500	0 53 11	1 4 28	264·74		1·23	0 47 39	1 2 42	251·76		1·23	0 50 3	1 7 59	235·80		1·29
600	1 6 32	1 22 43	261·62	126·7	1·54	1 0 49	1 22 51	234·89	126·0	1·57	1 4 23	1 30 50	218·51	111·0	1·66
800	1 35 46	2 4 18	230·81	73·1	2·21	1 31 4	2 11 28	209·08	69·3	2·35	1 37 48	2 27 0	192·43	61·3	2·52
1000	2 8 51	2 53 13	215·09	50·0	2·97	2 6 43	3 11 40	190·34	45·0	3·28	2 17 55	3 38 2	173·77	40·0	3·56
1200	2 45 20	3 48 49	202·81	37·3	3·81	2 48 0	4 24 0	176·16	32·0	4·34	3 5 35	5 5 40	159·79	25·3	4·78
1400	3 24 15	4 42 46	197·25	29·7	4·71	3 33 40	5 35 30	171·69	25·0	5·52	3 56 55	6 17 50	155·63	21·3	6·11
1600	4 6 58	5 47 30	193·20	24·0	5·69	4 24 35	7 4 10	168·58	20·0	6·83	4 56 15	8 15 30	152·07	16·7	7·63
1800	4 52 20	6 56 50	189·34	20·0	6·74	5 21 0	8 43 20	162·46	16·0	8·29	6 2 45	10 17 10	148·11	13·3	9·34
2000	5 40 45	8 11 20	185·74	16·8	7·85	6 22 55	10 33 0	157·37	13·3	9·88	7 16 40	12 33 0	143·14	10·7	11·24
2200	6 32 15	9 31 0	181·81	14·7	9·03	7 30 40	12 32 40	153·08	11·0	11·62	8 38 30	15 3 0	138·99	9·3	13·33
2400	7 26 55	10 55 35	178·42	12·4	10·28	8 44 35	14 43 20	149·42	9·9	13·51	10 8 55	17 47 0	135·44	8·0	15·63

* The pace = $0{\cdot}75^{m} = 2{\cdot}5$ ft.

TABLE III. (*continued*).—*Ballistic Data about the Small-arms in use.*

Range.	Switzerland. Vetterli repeating rifle.					Spain. Remington rifle.					Ideal rifle Y.			
	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Time of flight.	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Time of flight.	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.
paces.*	° ′ ″	° ′ ″	mètres.		seconds.	° ′ ″	° ′ ″	mètres.		seconds.	° ′ ″	° ′ ″	mètres.	
100	0 7 25	0 8 4	365·04		0·19	0 7 24	0 8 17	371·55		0·19	0 7 4	0 7 31	387·38	
200	0 16 8	0 18 49	317·58		0·41	0 15 55	0 18 12	328·87		0·41	0 15 6	0 16 55	349·21	
300	0 26 14	0 32 27	282·42		0·67	0 25 37	0 30 51	296·50		0·65	0 24 7	0 28 14	319·57	
400	0 37 43	0 49 3	255·44	Dangerous range = 418·5.	0·97	0 36 29	0 46 5	269·54	Dangerous range = 428·75.	0·93	0 34 8	0 41 32	295·91	Dangerous range = 469·5.
500	0 50 45	0 8 56	234·17		1·3	0 49 36	1 3 58	248·28		1·27	0 45 9	0 56 49	276·63	
600	1 5 17	0 32 6	217·00	109·3	1·67	1 1 58	1 23 56	234·00	124·0	1·58	0 57 12	1 14 9	260·66	148·0
800	1 39 10	2 29 3	191·10	59·5	2·54	1 32 32	2 12 41	209·00	68·0	2·36	1 24 25	1 55 3	235·75	80·0
1000	2 19 50	3 41 4	172·57	38·7	3·58	2 8 28	3 0 4	191·00	48·0	3·28	1 55 55	2 44 31	217·29	60·0
1200	3 7 45	5 9 20	158·69	25·0	4·81	2 49 57	4 24 55	182·20	32·0	4·33	2 31 47	3 42 45	203·07	39·0
1400	4 0 15	6 33 20	155·01	21·3	6·53	3 35 25	5 35 24	175·40	25·3	5·49	3 10 20	4 45 9	193·90	29·3
1600	5 0 25	8 22 40	151·01	16·7	8·31	4 26 15	7 3 0	169·28	20·0	6·78	3 53 50	5 57 40	187·02	23·3
1800	6 7 50	10 25 50	147·08	13·3	9·41	5 22 25	8 40 50	163·22	16·0	8·21	4 53 30	7 35 20	180·78	18·7
2000	7 22 55	12 43 30	142·16	10·7	11·31	6 24 0	10 28 40	158·18	13·3	9·77	5 31 5	8 40 30	175·57	16·0
2200	8 46 0	15 5 20	138·03	9·3	13·42	7 31 17	12 26 40	153·93	10·7	11·48	6 26 5	10 13 40	171·17	13·3
2400	10 17 50	18 2 0	134·51	8·0	15·74	8 44 30	14 34 42	150·31	9·3	13·32	7 25 20	11 54 0	167·40	11·4

* The pace = 0·75^{m} = 2·5 ft.

TABLE III. (*continued*).—*Ballistic Data about the Small-arms in use.*

Range.	Austria.												Converted arms.			
	Werndl rifle. Regulation cartridge.				Werndl carbine.								Austria. Wänzl rifle.		Russia. Krnka rifle.	
					Do. model of 1877.				Regulation do.							
	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Angle of elevation.	Angle of drop.	Remaining velocity.	Dangerous zone in paces.	Angle of elevation.	Angle of drop.	Angle of elevation.	Angle of drop.
paces.*	° ′ ″	° ′ ″	mètres.		° ′ ″	° ′ ″	mètres.		° ′ ″	° ′ ″	mètres.		° ′ ″	° ′ ″	° ′ ″	° ′ ″
100	0 7 22	0 8 5	362·11		0 13 3	0 13 38	291·85		0 14 43	0 15 13	278·96		0 9 36	0 10 28	0 12 37	—
200	0 16 9	0 19 7	311·5		0 27 15	0 29 27	273·03		0 30 34	0 32 43	260·42		0 20 56	0 24 25	0 27 7	0 27 46
300	0 26 29	0 33 23	274·32		0 42 15	0 47 29	252·48		0 47 49	0 53 0	242·91		0 34 3	0 42 0	0 43 28	—
400	0 38 36	0 51 9	246·2		0 59 26	1 7 56	243·94		1 6 41	1 16 32	226·54		0 48 55	1 3 12	1 1 42	—
500	0 52 5	1 12 37	224·24		1 16 54	1 29 33	235·02		1 27 26	1 43 54	211·31		1 5 46	1 28 26	1 21 49	—
600	1 8 0	1 38 45	206·69	102·7	1 37 7	1 56 17	222·32	82·2	1 50 23	2 15 47	197·15	68·7	1 24 25	1 57 53	1 43 49	2 17 24
800	1 44 4	2 41 41	180·48	61·3	2 21 4	2 55 36	207·6	49·3	2 44 15	3 36 14	171·98	40·0	2 7 39	3 6 54	2 33 49	—
1000	2 28 43	4 3 47	161·92	36·0	3 12 15	4 7 45	191·70	37·8	3 51 38	5 25 36	150·58	26·0	2 58 46	4 34 16	3 30 53	5 4 10
1200	3 22 10	5 46 0	148·15	25·3	4 11 45	5 34 40	179·86	25·3	—	—.	—	—	3 58 10	6 17 46	4 35 25	—
1400	4 35 5	7 50 30	144·12	19·0	5 21 5	7 19 10	169·54	18·7	—	—	—	—	5 7 0	8 19 30	5 49 45	—
1600	5 59 50	10 31 30	141·01	13·5	6 42 0	9 24 15	160·39	14·7	—	—	—	—	6 22 51	10 37 40	7 12 0	—
1800	7 32 10	13 23 0	137·36	11·0	—	—	—	—	—	—	—	—	7 55 15	13 25 10	8 43 50	—
2000	9 33 0	17 7 30	134·14	8·0	—	—	—	—	—	—	—	—	9 34 49	16 25 10	10 26 10	16 35 40

Dangerous range = 390.

Dangerous range = 372·4.

Dangerous range = 355.

* The pace = 0·75^{m} = 2·5 ft.

TABLE

Ordinates, in mètres, of the Trajectories with the Austrian,

	Horizontal							
	100	200	300	400	500	600	800	1000
2400	0·041	0·132	0·235	0·356	0·490	0·638	—	—
2300	13·707	**0·183**	0·389	0·631	0·898	1·195	1·883	2·702
2200	25·897	0·142	**0·452**	0·814	1·210	1·661	—	—
2100	36·61	11·844	0·413	**0·896**	1·430	2·025	3·401	5·039
2000	45·87	22·261	0·262	0·866	**1·534**	2·277	—	—
1900	53·777	31·289	10·110	0·725	1·526	**2·418**	4·482	6·939
1800	60·315	38·974	18·880	0·422	1·357	2·397	—	—
1700	65·544	45·356	26·353	8·500	1·068	2·257	**5·009**	8·283
1600	69·514	50·482	32·570	15·749	0·618	1·955	—	—
1500	72·263	54·394	37·582	21·792	7·012	1·486	4·924	9·017
1400	73·841	57·138	41·426	26·673	12·865	0·838	—	—
1300	**74·291**	58·760	44·252	30·438	18·348	5·636	4·126	**9·036**
1200	73·709	**59·352**	45·851	33·180	21·323	10·256	2·517	8·244
1100	72·175	58·984	**46·583**	34·945	24·112	13·886	4·477	6·543
1000	69·492	57·496	46·221	**35·378**	25·742	16·489	7·950	3·830
900	65·912	55·103	44·945	35·209	**27·001**	18·158	10·475	3·318
800	61·428	51·809	42·770	34·135	26·360	**19·318**	12·11	5·745
700	56·126	47·64	39·784	31·952	25·414	18·909	**12·937**	7·367
600	49·978	42·748	35·957	29·506	23·631	18·049	12·902	8·155
550	—	—	—	—	—	—	—	—
500	43·128	36·668	31·434	26·068	21·155	16·498	12·235	**8·253**
450	—	—	—	—	—	—	—	—
400	36·607	30·707	26·243	21·959	18·016	14·286	10·876	7·690
350	—	—	—	—	—	—	—	—
300	27·429	23·804	20·401	17·192	14·227	11·426	8·829	6·480
250	—	—	—	—	—	—	—	—
200	18·788	16·370	14·100	11·964	9·981	8·112	6·408	4·814
150	—	—	—	—	—	—	—	—
100	9·610	8·400	7·264	6·199	5·204	4·269	3·417	2·623
50	—	—	—	—	—	—	—	—
Abcissæ in paces.	2400	2200	2000	1800	1600	1400	1200	1000

Horizontal

Ordinates, in mètres, of the trajectories

IV.

French, Prussian, Russian, and Spanish arms.

range in paces.

1200	1400	1600	1800	2000	2200	2400	Abcissæ in paces.
—	—	—	—	—	—	—	50
3·661	4·711	5·907	7·206	8·721	10·359	12·166	100
—	—	—	—	—	—	—	150
6·955	9·055	11·446	14·044	17·073	20·344	23·956	200
—	—	—	—	—	—	—	250
9·811	12·961	16·546	20·445	24·982	29·886	35·298	300
—	—	—	—	—	—	—	350
12·113	16·311	21·040	26·288	32·328	38·862	46·072	400
—	—	—	—	—	—	—	450
13·802	19·047	25·017	31·519	39·056	47·216	56·218	500
—	—	—	—	—	—	—	550
14·775	21·067	28·036	36·031	45·060	54·841	65·632	600
14·938	22·275	30·622	39·731	50·244	61·642	74·213	700
14·189	**22·570**	32·102	42·518	54·507	67·517	81·863	800
12·428	21·852	**32·566**	44·290	57·744	72·362	88·475	900
9·549	20·012	31·907	**44·942**	59·851	76·070	93·942	1000
5·443	16·946	30·017	44·365	**60·719**	78·529	98·152	1100
2·335	12·539	26·785	42·446	60·232	79·628	100·99	1200
3·838	7·070	22·487	39·465	58·674	**79·650**	102·75	1300
—	0·844	16·584	34·881	55·497	78·044	**102·86**	1400
4·651	1·456	9·121	28·739	50·748	74·856	101·39	1500
—	1·966	0·656	20·947	44·332	69·995	98·220	1600
4·807	2·251	1·086	11·396	36·147	63·353	93·265	1700
—	2·408	1·267	0·438	26·095	54·835	86·399	1800
4·316	**3·021**	1·526	0·711	14·080	44·34	77·583	1900
—	2·333	**1·605**	0·926	0·333	31·771	66·654	2000
3·363	2·094	1·511	**0·968**	0·494	17·024	53·534	2100
—	1·733	1·296	0·889	**0·533**	0·163	38·120	2200
1·898	1·259	0·968	0·696	0·459	**0·222**	20·211	2300
—	0·679	0·533	0·397	0·279	0·155	0·049	2400
800	600	500	400	300	200	100	

range in paces.

with Martini-Henry rifle.

A TELESCOPIC SIGHT FOR FIELD GUNS.

BY

LIEUT. D. F. DOWNING, R.A.

The advisability of being able to lay even a field gun by means of a telescope with cross wires was first suggested to me at the annual practice of the battery by the impossibility of getting two men to lay two guns alike if left to themselves, and the consequent difficulty in obtaining the correct elevation by trial shots. Since then I have observed certain conditions in which the Nos. 1 declared themselves unable to lay when the object was quite apparent through glasses. In the early morning, at tolerably long ranges, it is very difficult to lay correctly, and certain conditions of ground, especially favourable to your own position (such as a slight rise with grass on it, &c.), render objects sometimes almost invisible which are really not so. Gun-pits and entrenchments are, as is well known, very difficult to lay upon with the unaided eye.

It seemed, therefore, to me that if a simple arrangement could be devised which would stand rough usage and at the same time retain its accuracy, it would prove a great boon in (1) ensuring greater accuracy of fire; (2) enabling you to fire under certain circumstances when you would otherwise have to move the battery to a fresh position or wait for a better light; and (3) relieving the strain on the eye in laying.

The instrument I am about to describe was made by myself, with the aid of the battery artificers; it had naturally, therefore, to be constructed on principles that did not involve any very nice finish of workmanship. From my own experience of the working of it, I was thoroughly satisfied with the results; the principal alterations it required being those of simplification instead of elaboration.

The material difficulties to be overcome in applying a telescope for use in laying a field gun are:—

1. *The means of attachment* must be such that no difficulty may be experienced in taking it off and laying it on, the mechanism must not be liable to injury in such ordinary operations as mounting and dismounting the gun, and there must be no chance of the relative position of the telescope to the axis of the gun altering in the operations of fixing and unfixing.

2. *The mechanism whereby elevation is given* to any extent must be simple, independent of the gun, and not liable to unintentional alterations.

3. *The elevation that can be given must not be limited.*

4. *The present sights must not be interfered with,* the telescope being really supplementary, and not intended to supersede them.

5. *The whole must be simple,* strong, and not liable to injury with ordinary usage, nor requiring constant adjustment.

In designing the following instrument I had to consider these conditions; and taking No. 3 first, I decided to fix the telescope on the muzzle (whence the gun would be laid) instead of at the breech; the No. 1 standing between the off wheel and the muzzle, and the No. 5 elevating from his own side (where the No. 1 would himself stand if working the wheel).

Taking No. 1 difficulty next, the frame of the instrument was fixed with regard to two possible motions by attaching it to a block fitted to slide into the notch of the fore sight, and with regard to a third by an arm which, being fixed to its other end, rested upon the chase of the gun.

Nothing thus being attached permanently to the gun, No. 4 difficulty was obviated, and the rest lay with

The Instrument.

This consisted essentially of five parts:—

(1) *The telescope* (one of the cross telescopes of an old Nolan's range-finder).
(2) *An arm,* to which the telescope was attached.
(3) *A frame,* in which the arm oscillated.
(4) *A sliding rest,* which ran along the upper surface of the frame, and on which the arm rested.
(5) *A screw shaft,* whereby the sliding rest was moved along the frame.

The frame is shown in Fig. 1; the only peculiarity about it was that the upper surface had to be flat.

The arm (Fig. 2) was of peculiar construction. The fore part consisted of a block which fitted accurately between the sides of the frame, through which on either side axles were driven into the block. The upper surface of the arm had to be level, but the lower surface of the portion behind the block was formed in a curve. Against this curve the sliding rest worked, and it was of such a nature that equal increments of motion of the rest along the level surface of the frame produced equal angles of motion of the arm about the axles in the block.

The screw shaft, which is also shown in Fig. 1, simply ran down the centre of the frame through one end, and was worked by a thumb-piece. The sliding rest geared upon the screw shaft, and naturally

equal turns of the screw shaft (or thumb-piece) produced equal motions of the rest along the frame; this produced equal angles of motion of the arm or equal angles of elevation.

FIG. 1.

(Scale $\frac{1}{2}$.)

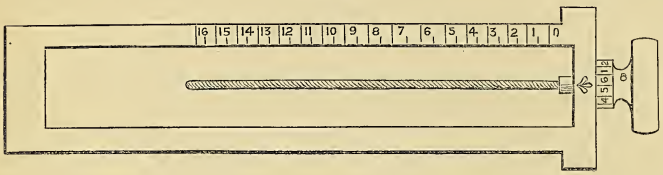


FIG. 3.
Sliding rest.

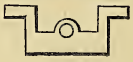
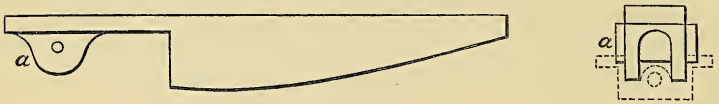


FIG. 2.



I arranged the curve on the lower surface of the arm so that 10 complete turns of the screw gave 1° of elevation, and I graduated the surface of the frame with divisions corresponding to the motion of the rest due to one turn of the shaft; I divided the circumference of the thumb-piece into six parts, and I was able thus to give elevations to 1′.

The form of the block which was to fit into the slot of the muzzle swell was a D, which slid over the fore sight and between the sides of the slot. This D was rivetted on to the fore end of the frame.

The hind rest for the frame was simply a plate, curved at its lower edge, to rest on the surface of the chase of the gun, and was so arranged as to shut up against the frame when the instrument was not in use.

There is no *necessity* for any deflecting arrangement (though I had made one); for I found that with the horizontal cross-wire of the telescope, to keep your elevation correct you could lay to the right or left of the target, and with better results than by giving deflection in the ordinary way.

In rivetting the D block on to the frame, the axis of the elevating arm was inclined at the 1° 30′ given to the tangent sight, and the axis of the telescope thereby caused to move in the same plane as the line of sight does, or rather in one parallel to it.

I was only able to fire six rounds to judge of the accuracy of my instrument. Of these, two were rendered useless as records by the time fuzes bursting short (I had no percussion); another (the second round) was incorrectly laid, owing to an incorrect signal from the range party, but fell almost exactly as far from the previous one as I had given elevation for. Of the remainder, one fell within 15, another 35, and another 5 yds. of the target, against 70, 50, and 70 of previous

practice without telescopes at the same range of 3000 yds. A strong and very variable breeze which was blowing diagonally across the range at the time of my trial would alone account for the variations above.

No difficulty of any importance was experienced in laying from the muzzle; it only required a little practice in the way of giving the words of command to the No. 5. The correct method of doing this was very quickly ascertained (and would be, of course, laid down for general use), and the result was a quicker laying than with the ordinary sights. There was one inconvenience, and that was a tendency on the part of the No. 1 to rest his arm upon the chase, in which case, if he bore down, the play of the elevating screw destroyed the laying.

It was objected that this method of sighting would be very awkward in a gun-pit. Perhaps it would; but everything is awkward in a gun-pit. It is quite *possible* to lay in this way from a gun-pit, just as it is to load with a muzzle-loader, though awkward.

I may, perhaps, be allowed to add that the gunners themselves were delighted with it, and I believe would be glad to forego the satisfaction of being comfortable for the more solid advantages of being "able to see things so clearly."

THE AUSTRIAN MOUNTAIN ARTILLERY IN THE CAMPAIGN IN BOSNIA, 1878.

BY

LIEUT. J. M. GRIERSON, R.A.

The Occupation of Bosnia by the Austrians, in fulfilment of the treaty of Berlin, has just been brought to a successful conclusion by the occupation of Novi Bazar; and everyone who has followed the movements of the soldiers of the Kaiser cannot but have been struck by the patience and heroic endurance, as well as courage, displayed by all arms of the service. Among the artilleries of Europe, that of the Austrian army has always held a high place, and well has it sustained its reputation in the late campaign. During the war, I had an opportunity of seeing some of their batteries, and was kindly permitted to examine the *matériel*, &c. I had hoped that abler pens than mine would have directed attention to their achievements in the field, as there are many useful lessons in mountain warfare to be learned from a careful study of this campaign against enemies who, from their thorough knowledge of the country, their warlike disposition, and the presence of a large number (25 battalions) of regular soldiers in their ranks, were by no means to be despised. After a short sketch of the organisation, equipment, mobilisation, and distribution of the mountain batteries, I propose directing attention to the tactics employed, in the hope that the study may be of interest to my brother officers.

I.—Organisation.

In the Austrian service, as in our own, mountain batteries are furnished by the garrison artillery. In time of peace only five exist—three in the 9th (Innsbruck) and one each in the 11th (Pola) and 12th (Carlstadt) Battalions—each of four guns. The peace strength of a battery is 1 captain, 1 first-lieutenant, 2 lieutenants, 3 staff-serjeants, 4 serjeants, 6 corporals, 16 bombardiers, 1 trumpeter, 54 gunners, 4 officers' servants, 1 shoeing-smith, and 1 collar-maker; or 94 of all ranks, with 4 riding horses, 1 spare and 8 pack mules. On the war footing the regulations prescribe that each battery shall be doubled, and thus 10 batteries formed, each with 1 captain or first-lieutenant, 1 lieutenant, 3 staff-serjeants, 2 serjeants, 5 corporals, 8 bombardiers, 1 trumpeter, 77 gunners, 2 officers' servants, 1 farrier, 1 shoeing-smith, and 1 collar-maker; or 103 of all ranks, with 5 riding horses, 46 pack and 2 spare mules.

II.—Equipment.

A mountain battery consists of four 7-centimètre breech-loading guns, of steel-bronze, with a wedge breech-block. The calibre is 6·6 centimètres (2·57 ins.), and the gun is rifled with 18 grooves. Its weight is 89·38 kilogrammes (196·6 lbs.), and the breadth of the track of the wheels is ·7 mètre (2 ft. 3½ ins.) The projectiles are common shell, shrapnel, and case; the extreme range for the first being 4000 paces, for shrapnel 2500, and for case 500 paces. The carriages are of iron, with oak wheels. The fighting line of a battery consists of 4 mules for the guns, 4 for the carriages, and 8 mules carrying 16 ammunition boxes. The second line has 40 ammunition boxes carried on 20 mules, 1 spare carriage, and a field forge carried by 2 pack-animals. Each gun has therefore 7 ammunition mules, carrying 112 rounds in all, in 14 boxes. Finally, there are 2 wagons or country carts, with 2 mules or horses each, for baggage, &c.; but these can be replaced in very difficult country by 19 pack-animals. The other three mules are for the officers' baggage, &c. With the divisional mountain parks are carried 100 rounds per gun.

III.—Mobilisation.

The special character of the operations in Bosnia necessitated a large increase in the number of mountain batteries. In all, 19 batteries were put upon a war footing by the different battalions. Four of them were those of the 11th and 12th Battalions, whose cadres existed in time of peace, and the latter battalion formed two new batteries. The battalion (1st) at Pesth furnished four, and those at Vienna (3rd, 4th, and 10th) two new batteries each, the *matériel* for which was furnished by the artillery field depôts at these places. At Josefstadt the 8th Battalion formed a battery, and finally in Dalmatia two reserve mountain batteries were mobilised with *matériel* of the 1863 pattern. The augmentation horses were all bought, and came mostly from Hungary, Salicia, and Dalmatia. The *personnel* was supplied by the battalions which formed the batteries.

IV.—Distribution.

An Austrian mountain division has three brigades of four or five battalions. To each of the brigades is attached a battery of mountain artillery, and one battery is kept as divisional artillery, along with a divisional mountain ammunition column. This was the formation of the 6th and 7th Divisions; the 18th Division had, in addition, as corps artillery, a heavy field battery, as it had to work independently (in the Herzegovina). The 20th Division (Szapary's) only received the usual brigade-division of three field batteries, and it retained the ordinary formation of two infantry brigades of six or eight battalions. The

13th Corps (6th, 7th, and 20th Divisions) received a corps artillery of two light and two heavy field batteries. The superior mobility of the divisions provided with mountain batteries was very evident; but unfortunately considerations of expense and rapidity of mobilisation prevented all the divisions which were successively mobilised in August, after the check of Szapary's division, from being equipped in this manner. By the time they entered Bosnia, however, many of the roads had been greatly improved by the untiring exertions of the pioneers, so the want of mountain batteries was not so much felt.

V.—Tactics.

The manner in which the Austrian guns were handled in the war in Bosnia forms a glaring contrast to the unintelligent and clumsy employment of the same arm by the Russians in 1877–8. Those latter, judging from the mutual admiration and *Kameradschaft* which existed between Germany and Russia (now considerably cooled down, however), might have been expected to have copied the tactics of the German artillery. Exactly the reverse happened. Dispersion of guns and dispersion of fire seem to have been the principles which ruled the handling of their batteries. The Austrians, while professing no such warm friendship and admiration, did not disdain to take a lesson from the Prussian artillery, to which they proved so superior twelve years before (1866), and had studied the artillery tactics of the war of 1870–1 ; and in every battle and combat of the Occupation we see those tactics applied and carried out, although, of course, on a very much smaller scale.

The fact was recognised by them that artillery is an indispensable adjunct to infantry, and we therefore find that every column, however small, had always a few guns with it. During the advance of the 6th Division from Doboi to Zepce, on either flank was detached a column consisting of two battalions and two guns, and these marched by paths about four to six miles distant from and parallel to the main route. How useful these guns were for opening defiles, &c., is proved by the engagement of the right column near Maglai on the 5th August. The troops had to march in single file in places, and near Maglai the path was held by insurgents. The two guns were at once brought into action, and the road cleared without further fighting. The same happened on the 7th near Noviseher, where a battalion of Turkish regulars was forced to retire by the same means. Had no artillery accompanied the small column, it must have become engaged in a difficult combat, which would have prevented its timely attack on the left flank of the insurgents at Zepce. The same proceeding is also noticeable in Villecz's turning movement on Han Belalovac on the 16th August. The single mountain batteries attached to small columns operating by narrow and bad roads must therefore push forward with boldness, and be always ready to open the way for the infantry or cover their deployment. The position of artillery in the column of march is the same in mountainous regions as on the plains.

The Austrians used advanced guards of from one-quarter to one-third of the strength of the column, and those had generally a mountain battery attached to them. On the 10th August, during the advance on Vranduk, the order of march of the 6th Division was as follows:—

Advanced Guard (half-an-hour in advance of main body).	1 battalion, 1 mountain battery, 2 engineer companies.
Main Body.	1 pioneer company, 1 battalion, 2 light batteries, each with 4 wagons (out of eight), 2 battalions. Remaining ammunition wagons with the Train.

A column was detached on either flank.

Again, in Szapary's advance on Dubosnica (7th August) the following was the order of march:—

Advanced Guard.	1 squadron, 1 engineer company, Infantry pioneers, ½ battalion, 1 battery (8 guns), ½ battalion.
Main Body.	½ battalion, 2 batteries (16 guns), 4 battalions.
Rear Guard.	½ battalion.

Here the tendency is plainly shown to push guns even more to the front than was usual in 1870, and wherever a collision with the enemy was expected the advanced guard was always strongly reinforced in artillery; as, for instance, in the advance to Maglai on the 5th August, when two mountain batteries were told off to the advanced guard of two battalions, in the advance on Zepce on the 7th, when the advanced guard was again raised to the same strength, and was three-quarters of an hour in advance of the main body, consisting of four battalions and a field battery, and again in the march of the 7th Division on Banjaluka on the 31st July, when the advanced guard was also strengthened by a mountain battery from the main body.

Special escorts were, as usual, told off to artillery when they had to act independently of other troops; as in the action of Banjaluka, on the 14th August, when the half-battery accompanying the force sent from Berbir was pushed on 4 kilomètres in front of the infantry, to relieve the hardly-pressed garrison. Infantry were mounted on the ammunition wagons, and a section of Uhlans accompanied the guns. It seems advisable always to provide a special escort of rifles or other

light troops for artillery in the mountains, as the facilities for surprise are so much greater than on the plains.

The employment of artillery on the battle-field appears to have been governed by the principles systematised by the German artillery. In all cases we see the advanced guard artillery brought at once into action, and the artillery mass gradually formed, and covering the deployment of the long columns. The ground rarely permitted of all the guns being united in a *grande batterie*, but in general they were all employed for the attainment of one object, though brought into action at different points. In the battle of Zepce, on the 7th August, the two mountain batteries of the advanced guard were brought into action together at 2000 paces range, and were shortly afterwards joined by a light field battery, which, not being able to find a position in line with them, had to advance to closer quarters. These three batteries first silenced the enemy's guns, and then turned their fire on the Han (inn), held by the insurgents, while the infantry deployed for the attack. At Rogelje, on the 5th August, the advanced guard battery was brought into action at 1400 paces, and when the insurgents were driven from their first position by the infantry of the advanced guard, this battery was advanced to 1600 paces from their second position, where a battery from the main body joined it. From here a heavy fire was brought to bear on the Kula (a stone block-house), which formed the key of this position. After it was stormed, one of the batteries was advanced to the captured position, to aid in the pursuit.

We see the same employment of artillery in the first day's battle (9th August), at Dolni Tuzla, where two heavy batteries were brought to bear on the enemy's guns, although from different points, and then the fire of both was turned on the strong posts of his line.

Again, at the capture of Serajevo, on the 19th August, towards 11 a.m., when the Austrian infantry were nearing the town from three sides, 52 field and mountain guns (all the artillery of the two columns) poured their shells on the devoted city. Of these, 24 field and 16 mountain guns specially directed their fire on the castle—the centre of the enemy's resistance. In the main artillery position to the west of Serajevo, on the Kosarsko Brdo, were three field and three mountain batteries—in all, 36 guns—all firing at the castle or citadel; range, 3200 yds. One of these mountain batteries afterwards pushed forward to about 250 yds. from the edge of the town, where the gardens, &c., were strongly held by insurgents, and overwhelmed them with storms of case and shrapnel (reversed in the bore). The other batteries were with the flank columns. It had been previously arranged that as soon as those batteries got within range of the town, they were to open fire on it; and thus a concentric fire on one object from many different points was obtained.

The necessity of a good preparation by artillery fire is shown by the failure of the attack by the 3rd Kaiser Jägers on Kremenac, on the 21st August. The battalion had to be withdrawn, after suffering heavily, and was forced to wait till the group of houses had been set on fire by the guns.

In places batteries could not find positions near enough to the enemy's line to be effective; but this did not hinder them from coming into action and detaining part of the enemy's forces by a slow fire at long ranges: as at Kremenac, on the 21st August, where a half-battery detained the enemy's left at 3770 paces while his right flank was being turned.

The tendency to push forward guns to decisive ranges (second artillery position) is strongly shown in several actions. At Kosna, on the 4th August, the batteries of the advanced guard were pushed forward from their first position (1500 paces) to a second, 800 paces from the enemy's line; but here they arrived too late, owing to the difficulties of the ground, and could not come into action, as their front was masked by their own infantry. At Banjaluka, Citluk, and Zepce, where the last position was at 1000 paces, the same principle is applied; but with mountain batteries this proceeding seems of doubtful utility, as their progress is of necessity slow, and there is a great chance, as at Kosna, of their reaching the second position too late.

Artillery was invariably used as a pivot on all occasions when a flank had to be turned. That this principle is fully recognised by the Austrians is seen from the orders of F. Z. M. Philippovic for the advance on Vranduk. He says:—"My intention is to carry out an enveloping attack, and leave the principal work to the flank columns, while the centre will have to carry on a demonstration, supported by strong artillery fire," and the same orders are again repeated for the advance on Han Belalovac. At Zaice, the enemy's left, which made several attempts to advance and envelope the Austrian right, was held in check by the fire of two mountain batteries, while the entire force changed front to its right, with the guns as a pivot, turned the insurgents' right, and drove them back on Zaice. Precisely the same proceeding was employed at Kremenac, where the army effected a change of front to its right, an artillery position being the pivot.

Batteries were invariably advanced to the conquered position to fire on the retreating enemy. After Zepce, the retiring insurgents were shelled up to 4000 paces by the 10/XII. Field Battery.

As regards the defensive battle, the insurgents showed great skill in placing their guns so as to command the approaches to their positions, but no examples of the defensive occurred on the Austrian side during the war. Szapary's retreat from Dolni Tuzla on the 10th August was covered by twelve guns, which held their position till the last body of infantry was withdrawn from the fighting line. At one time they were in great danger, as the insurgents threatened to storm them; but they ultimately succeeded in retiring by successive divisions.

In a tactical point of view the campaign in Bosnia seems therefore to teach us that the employment of mountain artillery on the field of battle in no way differs in principle from the employment of the arm on the plains, but that it is all the more necessary to push guns to the front, to protect the deployment of a long column marching on one road, and, it may be, in single file in places, as often happened during the war. To effect the formation of the *grande batterie* as soon as

possible, it is therefore advisable to place the guns as far forward in the column of route as is consistent with their safety.

In the mountains it is seldom that an entire division of from 6000 to 9000 men can operate by one route or in one body; brigades will therefore frequently have to work independently. We pointed out above the benefit which accrued to the small Austrian flank columns from their being provided with guns, and comparing the organisation of the Austrian with that of the English divisions in Afghanistan, the system of the former of having four guns *permanently* attached to each brigade, and always accompanying it when detached, and also a divisional artillery of one or two batteries, appears preferable to ours of having all the artillery in one brigade division and under one command.*

The nature of the communications and the configuration of the country must greatly influence the question as to whether mountain guns only or a proportion of field artillery should be attached to divisions destined to operate in the mountains. The difficulties of the march in Bosnia were at times enormous. In the advance to Maglai, on the 5th August, in the right column the mountain guns with their stores had several times to be unpacked and carried by hand across streams with precipitous, rocky banks, while the mules crossed unloaded. We have seen above how useful these guns proved afterwards. In the battle of Zaice a mountain battery had to be carried up by hand into a position, and then brought into action. There can be little or no doubt that the failure of Szapary's advance on Dolni Tuzla was caused in no small measure by the organisation his division had received. He had only three *heavy* 9-centimètre field batteries, and it took five complete days to bring his batteries and train columns (with wheeled carriage) from Gradacac to Gracanica—a distance of 30 kilomètres (about 19 miles)—and still the road was no worse than those traversed by the 6th and 7th Divisions. In places 30–40 men had to be used to haul along each carriage. Thus three precious days were lost, and the insurgents gained time to concentrate at Dolni Tuzla. In the 6th Division, the two heavy batteries had to be left at Han Marica on the 3rd August, and their horses used to assist the train columns. They did not rejoin the division till after its arrival at Zenica on the 14th August. Still the advantage of having heavy batteries, as shown at Sarajevo and at Ali Musjid in Afghanistan, is enormous, and may in part counterbalance the delay caused on the line of march by their presence in a column. Mountain batteries should be able to go wherever a foot-soldier can march.

The question is suggested by the experience of this campaign, Could not the *matériel* of mountain artillery be lightened? For example, what is the use of wheels? In the "Russian Artillery Journal" of April, 1879, there is a review of a project for a mountain carriage without wheels, and a model of such a carriage was exhibited

* The Austrians, of course, have an O. C. Artillery on the staff of the division, and the divisional artillery is directly under his orders.

in the Paris Exhibition of 1867. Neither in Bosnia nor in Abyssinia does a case seem to be recorded in which a mountain battery used its wheels for transport. Thus a mule per subdivision (in our service) would be saved, and the column correspondingly shortened. We have now the most powerful mountain gun in Europe; why should not our organisation and *matériel* be also improved, and our mountain batteries, which we recently have seen so magnificently handled at the Peiwar Kotal and elsewhere, be made as much patterns of organisation and equipment as their *personnel* are models of all soldierlike qualities?

WOOLWICH,
October, 1879.

MOUNTAIN GUNS

FOR

INDIAN FRONTIER SERVICE.

BY

CAPT. E. WALSH, R.A.

The experience gained in the recent operations against the Jawaki Afriedies would seem to indicate the advisability of supplementing our mountain artillery with more powerful guns than the 7-pr. M.L.R., with which the mountain batteries on the Punjab frontier are now armed.

This subject has already attracted the attention of several experienced officers, and it is possible that a gun such as that invented by Lt.-Col. C. B. Le Mesurier, R.A., may supersede the 7-pr. M.L.R. of 200 lbs. In the meantime, however, it behoves us to consider how to make the best use of guns immediately available—such as, for instance, the 9-pr. M.L.R. of 6 cwt.

In the campaign above referred to, four of these guns, carried on elephants and manned by gunners of "I" Batt., "C" Bde., R.H.A., accompanied the Peshawar Field Force, and played an important part in the capture of the Shergadra Heights, as well as in the subsequent operations in the Bori Valley, and I think I cannot better illustrate my subject than by giving a brief account of their performances.

The battery marched out of Peshawar at 10 a.m. on the 2nd Dec., 1877, and, notwithstanding the slippery state of the road, and several deep ravines which had to be crossed, reached Fort Mackeson before sunset on the same day.

In the morning of the 3rd December a slight reconnaissance was made in the direction of "Kundas," and the enemy was found to have taken up a strong position on the Shergadra Ridge, which separates the Bori from the Peshawar Valley, over which it has an average command of 1200 ft. The general direction of this ridge is east and west. It is steep and rugged, and sparsely covered with brushwood, consisting of wild olive and "sinutta" bushes. The crest is covered with rocks and loose boulders, which were turned to good account by the enemy in the construction of "surgahs," or rude breastworks.

In the afternoon of the 3rd the 40-pr. battery, with a strong escort

of the Rifle Brigade, marched about six miles eastwards from Mackeson, and took up a position facing the enemy's centre, so as to avoid delay in the attack which was to be made on the following morning.

Late on the same evening the following orders affecting "I" Batt., "C" Bde., R.H.A., were received:—

The right division of the battery, with elephant equipment, to march with the right brigade (Col. Doran's) at 5 a.m.
The centre division, also with elephant equipment, to march with the left brigade (Col. Buchanan's) at 3.30 a.m.
The left division, with all the horses, drivers, wagons, limbers, &c., to return to Peshawar.

At about noon on the 4th December the attack was commenced by the 40-pr. battery, which opened fire with shrapnel at 3000 yds. range, and the skirmishers, extending in front of their respective brigades, soon cleared the ground to the foot of the hills, and obliged the enemy to take to his surgahs.

The R.H.A. then pushed smartly forward from both flanks, and opened a steady and well directed fire of common shell with percussion fuzes at ranges gradually increasing from 1500 to 2500 yds.

Meantime the 40-pr. battery had got the exact range of the enemy's breastworks, and was firing with effect.

The infantry charged gallantly up the rugged hill side, and the Shergadra Heights were carried.

The R.H.A. guns were immediately limbered-up—*i.e.*, packed on elephants—and those attached to the left brigade reached the crest of the ridge without much difficulty, by a sort of camel track dignified by the name of the "Bori Road." The guns on the right had a longer way to go, and were obliged, moreover, to wait until a practicable road could be extemporised.

Here I mention an incident showing how considerable delay was avoided by taking advantage of a physical peculiarity of the elephant —*i.e.*, the tenderness of his feet.

The right division ("I" Batt., "C" Bde., R.H.A.) having received orders to advance as quickly as possible, had got about half-way up, when they found all further progress barred by a projecting rock. Some sappers immediately set to work with sledge-hammers, and, by dint of almost superhuman exertions, reduced the projection by 8 or 10 ins. Nothing more could be done without blasting, and still it was found impossible to make the elephants pass owing to the care with which they avoided the precipice on the other side. At this juncture a happy thought occurred to the commanding officer, which solved the difficulty in about two minutes. This was, to make a smooth narrow path along the edge of the precipice, and to strew the other side of the road with sharp splinters of rock. It was a complete success. The first elephant, in much fear and trembling, was induced to make the attempt, and as he got over all right, the others followed gaily. We then pushed on and joined the rest of the battery a little before sunset, at *c*—a point on the crest of the ridge 1½ miles east of Kundas.

Before concluding the account of this day's operations, I should mention that the Jawakis did not wait for the final rush of our infantry, but bolted down the other side of the ridge, and, rallying behind the crest of a small detached hill, opened a practically ineffective fire on our troops. The range was about 700 yds., which was beyond the capacity of Jawaki weapons. A few of them, however, had English rifles, and they were just beginning to get our range when a round or two of shrapnel induced them to retire for the night, and we were not sorry to turn in too. The leaves of the "sinutta" afforded most luxurious bedding, and we slept very comfortably, *à la belle étoile*.

The enemy did not molest us during the night, but early next morning (5th December) a few sharpshooters armed with Enfield rifles opened fire on us again from the crest of the detached hill in front. The General at once determined to dislodge them, and this was done in first-rate style by a detachment consisting of one company of the 9th Regiment and two companies 14th Sikhs.

Our loss on this occasion was trifling, and the hill was a very important acquisition, as it not only secured the only weak point of our position, but also commanded a considerable extent of broken ground on the south side, where the enemy might have approached unperceived.

In the meantime our picquet at *d* was attacked by a considerable body of the enemy, who were strongly posted on a semi-detached knoll (*f*); but the 20th Punjab Infantry held their ground all day, and eventually beat off the enemy, and got possession of the knoll (*f*). There was not a single casualty on our side in this affair, but the Jawakis lost three killed and several wounded.

Nothing else of importance occurred during the day; but at about 12 midnight the enemy attacked our outlying picquet on the detached hill in some force, but, finding the Martinis and Sniders too many for them, soon retired without doing much damage.

Before proceeding further, it may be well to glance at the map. The point *a* on the top of a steep hill commanding the village of Kundas was the position taken up by the right division ("I" Batt., "C" Bde., R.H.A.) on the 4th December, while the other two guns were at *b*. *c* was the centre of the enemy's position on the Shergadra Ridge (*g, c, d, f*), which, as before-mentioned, runs nearly due east and west, separating the Peshawar Valley on the north from the Bori Valley on the south. The latter is well watered and fertile. Its average breadth is about 1800 yds., and its general level is about 800 ft. above the Peshawar Valley. It is bounded on the south by a lofty and precipitous range of hills, from which numerous spurs run in a northerly direction, and terminate very abruptly. The principal villages are named respectively "Bori," "Spintung," and "Toto-Khel," all situated within musketry range of the rocky spurs above mentioned, and protected by mud walls and massive towers.

The Jawakis were doubtless emboldened by our apparent want of activity on the 5th December; for on the following morning they were quite eager for the fray, swarming in the villages and planting their

standards on the neighbouring heights. These heights had been numbered from right to left, looking from our position at *c*, and their distance carefully ascertained.

At daybreak on the 6th December the field force descended into the Bori Valley, and soon reached the nearest villages, which had in the meantime been shelled by the four 9-prs. on the ridge at *c*. The range was 2000 yds., and common shell with percussion fuzes were used.

The Jawakis, finding the villages too hot for them, soon retired to the crests of the rocky spurs (1, 2, 3), whence they opened fire, under the impression that they were out of our reach, and that their position was unassailable. The fallacy of this idea was soon made apparent when we opened on them with shrapnel at ranges varying from 1800 to 2400 yds. The artillery fire was very quick and effective, and enabled our skirmishers, who had advanced with admirable caution as far as the villages, to make their rush across the open space to the foot of the hills without suffering much loss. Here, owing to the steepness of the spurs, the infantry were completely defiladed from the enemy's fire, and were thus enabled to take breath before the final scramble.

Thus Nos. 2 and 3 spurs were crowned with very trifling loss on our side, and the enemy's position on No 1 was no longer tenable, as it was commanded and taken in reverse by No. 2. From our position at *c*, on the Shergadra Ridge, we could see the Jawakis bolting in considerable numbers; but of course we were obliged to discontinue the shrapnel fire out of regard for our own infantry, and had to content ourselves with dropping a common shell among them occasionally. In this way we made some very fair practice up to 3000 yds., beyond which it was no use firing, as we could not judge of the effect produced.

Meanwhile the sappers were busily engaged in blowing up the towers in the valley. These towers were from 30 to 40 ft. high, the lower half being solid, and further strengthened by heavy beams imbedded in the masonry. The door was about 15 ft. from the ground, and was reached by means of a moveable ladder.

In order to demolish these towers completely it was necessary to dig a deep hole in the centre of the solid basement. The charge varied from 70 to 100 lbs. of powder, according to the size of the tower, and was ignited with Bickford's fuze.

On this occasion (6th December) three towers were blown up, and as the explosions occurred almost simultaneously, the effect was very pretty, and could be seen to the best advantage by the late owners, who were perched on the neighbouring heights. The General now gave the order for our troops to retire, having previously signalled to us to keep up a heavy fire during the operation.

Directly the retirement began, the Jawakis came on with renewed ardour, and though there was not much difficulty in keeping them at a distance as long as our infantry held the ridges, there can be little doubt that our loss would have been severe but for the rapid and deadly fire of the 9-pr. guns, which was brought to bear upon the crests of Nos. 2 and 3 spurs as soon as their evacuation by our infantry rendered it safe for us to shell them.

The expenditure of ammunition on this occasion was very con-

siderable—viz., 345 rounds, or nearly 84 rounds per gun; but though this may at first sight seem a little extravagant, it must be remembered that our supply was practically inexhaustible—namely, the first reserve, which lay ready packed in our second line of wagons, and the whole stock in the Peshawar Arsenal to fall back upon if necessary.

After a very hard day's work, the troops returned to *c*, on the Shergadra Ridge, and bivouacked that night undisturbed by a single shot from the enemy.

The operations of the 7th December were very similar to those of the 6th, except that the guns were moved to *d*, about two miles eastward along the crest of the Shergadra Ridge.

This was an admirable position, commanding the whole of the eastern end of the valley, and before the arrival of the guns, a company of sappers, under the direction of an officer of the battery, had prepared excellent "emplacements" for them—a very necessary precaution, as the rough work to which they had been subjected on the 4th and 6th had strained the carriages a good deal. Indeed, one axletree was considerably bent, and its wooden bed completely smashed.

The Jawakis fought well, but were obliged to retire, as usual, and our troops, after blowing up five or six towers, returned to bivouac at *d*.

On the 8th December the guns remained at *d*, and all the remaining towers were destroyed with very little opposition.

Up to this time we had enjoyed splendid weather, and though it froze pretty hard at night, we were comfortable enough in the open; but on the afternoon of the 8th a drizzling rain set in, which gradually changed to a steady downpour.

There was no shelter of any sort, and the troops had a wretched night of it. However, they bore their misery very cheerfully, most of them marking time on the rocks all night to keep up their circulation, and others, too tired for this exercise, lying in the mud with their clothes wet through.

The prospect was not much brighter next morning (9th December), and as nothing was to be gained by remaining in this inhospitable region, it was determined to withdraw most of the troops to the lower camp, leaving a strong picquet to hold the position at *c*, commanding the two roads leading from the Peshawar to the Bori Valley. The gunners had rather a rough time of it, as they had to take off their cloaks in the pouring rain and set to work packing the guns, carriages, and ammunition on the elephants.

All this was soon done, though the men were faint with hunger and want of sleep, and numbed with cold; everything, moreover, including the skids and parbuckle-ropes, was wet and slippery, which made great care necessary to avoid accidents. Then commenced the dreariest march imaginable. The elephants, with characteristic caution, felt every inch of the ground as they crawled along. They did not like the slippery mud, and objected strongly to the sharp rocks which cropped up on all sides. The four guns were placed in their old position at *c*, and a strong picquet (detailed in Appendix C) being left to hold the Shergadra Ridge, the rest of the troops were withdrawn to the lower camp.

The Jawaki power was now completely broken; still they showed no signs of submission, but, on the contrary, annoyed us considerably by firing into our picquets at night.

Nothing of importance took place till the 25th December, when a reconnaissance in force was made as far as the "Pactaoni-Kotal." Two guns R.H.A. were in action at *d*, and were of great use in protecting the advance and retirement of our troops.

On the 31st December an advance was made by a considerable force, including Captain de Lautour's mountain battery; and again two guns R.H.A. co-operated from the point *d*, as also on the 2nd January, when the troops holding the Kotal returned to Shergadra.

On the 15th January communication was opened between the Peshawar and Kohat columns, and on the following day a simultaneous advance was made on Walai. The combined forces marched through the whole extent of Jawakiland without encountering any opposition, and, in the meantime, an accurate survey was made of a large tract of country hitherto absolutely unknown.

The 1st and 2nd Brigades, composing the Peshawar Column, returned to Shergadra *viâ* Kohat on the 22nd and 24th January respectively, and the campaign being practically at an end, it only remained to withdraw the troops to Peshawar.

The 9-pr. guns were carried on elephants as far as Fort Mackeson, where we bade farewell to those useful but lumbering animals on the 28th January, and hooking in the magnificent teams of "I" Batt., "C" Bde., R.H.A., marched gaily back to Peshawar.

This was a bloodless campaign, as far as the battery was concerned, but the importance of the results achieved by the 9-pr. guns received a very practical acknowledgment in the fact that before the outbreak of the Afghan war in 1878, another battery—namely, "F" Batt., "C" Bde., R.H.A.—was equipped in a similar manner. Moreover, although we managed to bring our guns into action without elephants in the attack on Ali Musjid, 21st November, 1878, there is not the slightest doubt that had the Afghans held out for another day we should have found the assistance of these animals invaluable; and I may mention that a certain number were on the spot, ready equipped, to provide for such a contingency.

These things being so, it only remains for us to consider whether a sufficient number of these guns to meet the ordinary requirements of our frontier service could not be brought into the field without breaking up a battery of horse artillery, or at least diverting it from its proper *rôle*.

What I would suggest is the substitution of three 9-pr. M.L.R. guns of 6 cwt. for the present obsolete armament of the left half of our heavy batteries, which consists now of 2·8-in. mortars and 2·5½-in. mortars. It is difficult to imagine what object is supposed to be gained by dragging these venerable pieces about with a battery; whereas about half the number of bullocks kept up by Government for this apparently useless purpose would suffice with a 9-pr. armament.

For everything except mountain warfare the bullock teams would

do very well, and therefore I think there would be no necessity to increase the regular establishment of the battery by 12 elephants.

The elephant gear should be kept on charge in the battery, and the men should be frequently drilled with elephants. For this purpose three elephants would be sufficient, and these could be borrowed from the Commissariat Department twice a week.

Similarly, when required to proceed on hill service, it would only be necessary to obtain 12 elephants—*i.e.*, four per subdivision—from the same unfailing source.

In conclusion, I should add that I have only refrained from advocating the eight-gun battery system from a feeling that any remarks of mine on the gigantic subject of artillery organisation would be out of place on the present occasion.

ADEN, ARABIA,
1st October, 1879.

APPENDICES.

A.

Composition of the Peshawar Field Force assembled at Fort Mackeson on 3rd December, 1877.

Commanding—Brig.-Gen. Ross, C.B.

Staff { Capt. W. Boyes, A.-A.-G.
" J. M. Trotter, A.-Q.-M.-G.
" Brownrigg, D.-A.-Q.-M.-G.
Lieut. Heath, "

Commanding R.A.—Col. W. J. Williams, C.B.
Adjt. R.A.—Capt. Smith, R.H.A.

"I" Batt., "C" Bde., R.H.A.—Major Manderson, R.H.A.
13 " 9th " R.A., " Wilson, R.A.

17th B. Cavalry—Col. Watson.

Infantry { 2/9th Regt.—Col. Buchanan.
51st " " Madden.
Det. Rifle Bde.—Capt. FitzHerbert.

Native infantry { 15th Sikhs.—Major Wanchope.
20th P.I.—Col. Rogers.
22nd P.N.I. " O'Brien.
27th " " Doran.

Sappers, 3 companies.—Lieut. Bartram, R.E.

B.

Distribution of the P. F. Force, on the 4th December, 1877.

1st (Right) Infantry Brigade, Col. Doran Commanding.

51st Regt.—Col. Madden.
22nd P.N.I.—Col. O'Brien.
27th " Major Birch.
2 guns R.H.A.—Lieut. Walsh.

2nd (Left) Infantry Brigade.—Col. Buchanan Commanding.

2/9th Regt.
14th Sikhs.—Major Wanchope.
20th P.I.—Col. Rogers.
2 guns R.H.A.—Major Manderson.

RESERVE.

3 guns, 13 Batt., 9th Bde., R.A.—Major Wilson.
2 companies Rifle Bde.—Capt. FitzHerbert.
3 " Sappers.—Lieut. Bartram, R.E.
17th B.C.—Col. Watson.

C.

Shergadra Ridge Picquet, 9th December, 1877.

Col. Rogers, 20th P.I, Commanding.

Infantry { 1 comp. 9th Regt.—Capt. Airey.
2 comps. 14th Sikhs.—Lieut. Radcliffe.
20th P.I.—Col. Rogers.

4 guns R.H.A.—Lieut. Walsh.

N.B.—Two of these guns were afterwards sent to the lower camp, under command of Lieut. Hepburne.

D.

Detail of a Subdivision ("I" Batt., "C" Bde., R.H.A.) with Elephant Equipment.

1st Elephant { 9-pr. M.L.R. gun.
2 long skids.
1 parbuckle-rope.

2nd Elephant { gun-carriage complete.
2 carriage lifters.
4 drag-ropes.

The 3rd and 4th elephants each carry four boxes of ammunition, and there is one spare parbuckle-rope, and one spare lifter per division.

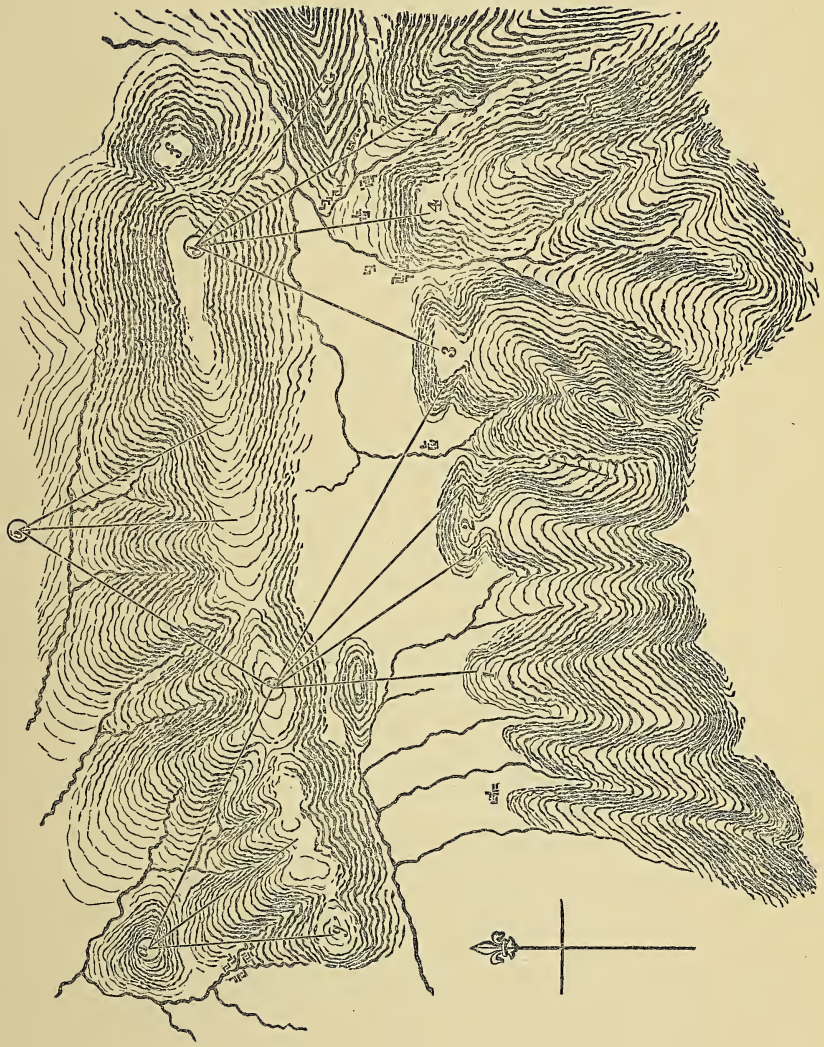
MAP

SHOWING THE POSITIONS OF THE 9-PR. M.L.R. GUNS,

"I" BATT., "C" BDE., R.H.A.,

DURING THE

JAWAKI CAMPAIGN, 1877-8.



Scale, 2000 yds. = 1 in.

THE WELDON RANGE-FINDER.

BY

MAJOR J. B. RICHARDSON, R.A.

The use of range-finders in scientific warfare is recognised as a necessity by nearly all the military powers; but hitherto no satisfactory instrument has been forthcoming.

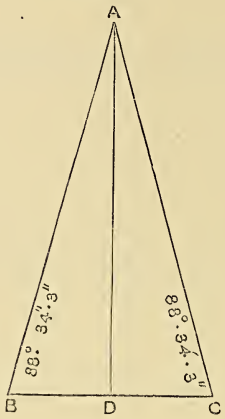
To many a hard-working battery officer who has toiled wearily on, instructing men in the art of range-finding with the highly-complicated instruments adopted in our service, happy if, by chance, he has succeeded in training, after hours and hours of instruction, say one N.C. officer in his division to find ranges accurately enough for the result to be depended on, the news that an instrument has been invented simple enough for an uneducated man to work effectively will be most welcome.

Such a system of range-finding has been perfected by Major Weldon, of the Madras Staff Corps. It may be taught to an intelligent man in an hour, and to men of poor education—the class with which one mostly has to deal—in from three to four hours. The instrument used is extremely simple, devoid of calculators, verniers, cylinders, screws, springs, racks, or anything likely to get out of order; extremely portable, and so cheap that every N.C. officer might possess one, and carry it in his pocket. By this system a range may be found in the time that it takes to dismount and put a Nolan's instrument together, or while with a Watkin's the horses are being knee-haltered and the pickets being planted; and the ranges found can be depended upon.

All range-finders depend for the accuracy of result on the length of the base. When the base subtends an angle of less than 2° the result is unreliable, unless instruments are used far too delicate for rough service work. Again, if the angle subtended by the base is greater than 3°, the base is unnecessarily long. In all range-finders worked with an arbitrary base the error increases with the distance; Major Weldon's system secures unvarying reliability at all ranges, by making the base

proportional to the sides of the triangle which converge on the distant object. He reasoned thus :—

Fig. 1.



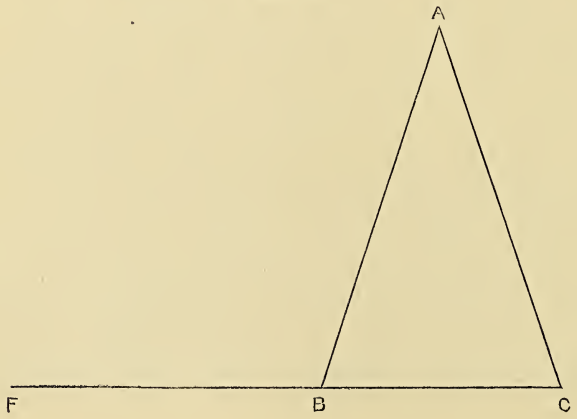
In an isosceles triangle *ABC*, of which the angles *ABC*, *ACB* are each 88° 34′ 3″, and *AD* is a perpendicular,

$$AB = BD \sec 88° 34′ 3″$$
$$= \frac{BC}{2} \times 40$$
$$= 20\, BC.$$

He applies this reasoning practically thus :—

Suppose an observer (Fig. 2) at *C*, with an instrument capable of reflecting an angle of 88° 34′ 3″, sees *A* reflected along a line *CF*. If an observer provided with a similar instrument moves in the direction

Fig. 2.

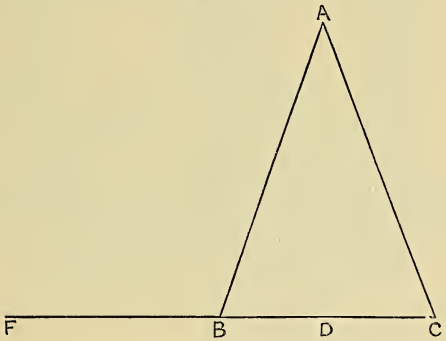


F to *C*, he will arrive at a point, *B*, where he will see *A* reflected on *C*. *ABC* will then be an isosceles triangle having the angles *ABC*, *ACB* each = 88° 34′ 3″, and 20 times the base, *BC*, will equal *AB* or *AC*.

Or suppose there is only one instrument forthcoming; then the observer, by using two pickets, can obtain the same result thus :—

Planting a picket, *D* (Fig. 3), at random, he moves until he finds at

Fig. 3.

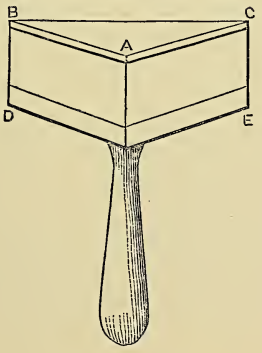


C a place where *A* is reflected along the line *CDF*, and here he again plants a picket. Moving along the line *CF*, he arrives at a spot, *B*, where *A* is reflected on the line of the pickets *D* and *C*. As before, 20 times *BC* = *AB* or *AC*.

After some years spent in attempts to obtain the satisfactory reflection of an angle of 88° 34′ 3″, Major Weldon has now introduced an instrument so simple that until used it is difficult to believe that with such an apparent toy, distances varying from a few yards to many thousands of yards can be accurately measured. Its cost, at present, is about 30 shillings. It is little larger than a walnut, weighs but a few ounces, and can be carried in a small pocket. It requires no adjustment, and will stand rough usage.

Fig. 4.

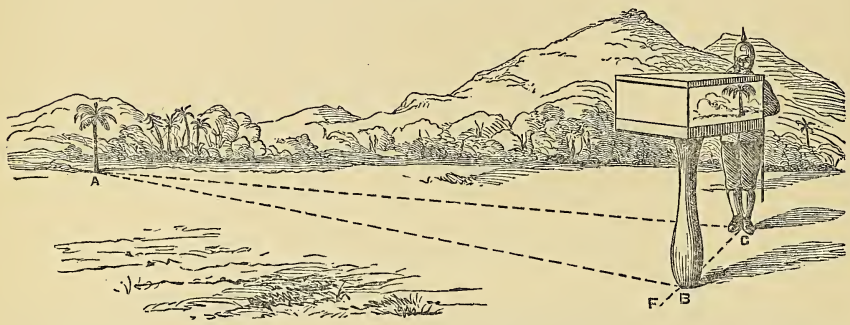
(Real size.)



It consists of a plate-glass prism bound in brass, having the angle *BAC* carefully ground to 88° 34′ 3″, the back, *BDEC*, being silvered, so as to act as a mirror. Its cost is great, owing to the care which has to be given to cutting the angle accurately. In practice, this instrument, small as it is, is found to work perfectly, giving ranges with great accuracy.

The drawing (Fig. 5) will explain its use. The sketch is necessarily much exaggerated. It is required to find the distance of the

Fig. 5.



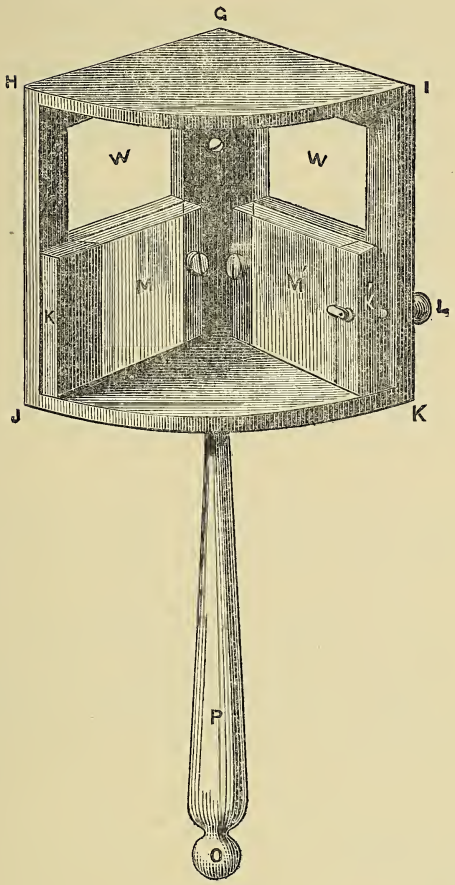
palm tree, *A*. The observer moves along the line *CF* until he sees the palm tree and the eye of the soldier at *C* coincide. The soldier at *C*, provided with a similar instrument, sees the palm tree and the eye of the observer at *B* reflected in a similar way. Then each of the angles *ABC*, *ACB* = 88° 34′ 3″, and *AC* = 20 *BC*.

Major Weldon also works with another instrument, rather larger and perhaps slightly more complicated, but nevertheless extremely simple. It is far cheaper than the last described—costing about 15 shillings—and is easy of adjustment. The instrument (Fig. 6) consists of a solid brass case, *HGIJK*, in the form of a segment of a cylinder, the apex angle being taken greater than 89°, having two oblong openings, *W*, in each side, and underneath each of these windows a block, *K*, in which is fixed a mirror, *M*. The block on the left-hand side is firmly fixed with screws, but the block on the right is capable of slight adjustment by screws at *L*. The mirrors are inclined to one another at an angle of 88° 34′ 3″. A handle, *P*, is screwed to the case, for convenience in using the instrument, and there is a loop at the end of this handle, to admit of the attachment of a lanyard, so that it may be carried round the neck and stowed away in a pocket without being liable to a fall.

When using the instrument, it must be held with the open side towards the eye, but nearly half-turned in the direction of the object to be reflected, so that on looking into the instrument only one reflector is visible, in which will be seen objects to the right or left of the observer.

Fig. 6.

(Real size.)



Major Weldon's directions for finding the range exhibit the practical working of the instrument.

To find the Range with two Men.

"No. 1 goes to the right and finds the angle, No. 2 goes to the left and finds the base. The two men stand facing the object. They carefully note and agree on some prominent point on it to be observed in the angle-glass.

"They then turn outwards, note the particular spot on the ground in front of each that coincides with the reflected object, and march straight on the spot until they reach the estimated length of base.

"They now turn inwards, and No. 2 stands steady while No. 1,

moving, makes an angle with him and the object, and when that is effected he stands steady. No. 2 now sees in the angle-glass whether the reflected object falls to the right or left of No. 1. If on the right, No. 2 must retire, to increase his distance from No. 1; if on the left, he must advance, to lessen his distance. After each move No. 2 halts and stands steady, for No. 1 to make a fresh angle.

"In this manner Nos. 1 and 2 alternately move and halt until they get the object fairly reflected on each other.

"The distance between them is then measured, to determine the range of the object."

In practice Major Weldon either paces the base (which from practice he does very correctly, and obtains very fairly accurate results), or he measures it by a line of thin cobbler's twine—a material he finds to answer better than tapes, &c. Of this line he carries 150 yds. (answering to a 3000 yds. range), wound on a simply constructed reel, marked and numbered at every five yards. Each of these marks correspond to 100 yds. of range, and are so figured. No strain comes on this line. The man measuring moves straight from point to point; the line, as it unwinds from the reel, lies fair on the ground.

In rewinding the man walks rapidly back, winding up as he goes instead of pulling the line to him. The wooden disc or reel for 150 yds. of this measuring twine is so thin that it can be used in the highest wind.

The ease with which the range of moving objects is obtained by two observers with the Weldon instruments is very remarkable; but for such objects practiced men are required. The distance of infantry firing from under cover has been ascertained by the puff of smoke from their rifles. The position of hidden guns could doubtless be obtained in the same manner.

St. Thos.' Mount, Madras,
August 20, 1879.

FURTHER NOTES

ON THE

OFFICE WORK OF A GARRISON BATTERY.

BY

MAJOR R. PHIPPS,

ROYAL ARTILLERY.

The Notes now printed are a continuation of those that appeared in the Institution's Proceedings for May 1879, Vol. X., No. 6. A Manual of Office Work ought to fulfil certain conditions:—First, it should contain sufficient general description to enable any one coming fresh to the work to understand the principal points to attend to, and the connection between the different accounts. Secondly, it should give enough special detail to prevent errors in the treatment of the ordinary casualties. Thirdly, it should be short enough to be reprinted annually and sold for 6d. or 1s. Such a manual would be useful as a means of recording the numerous alterations made from time to time in the ordinary routine, which are now so often and so inevitably overlooked. Its contents would vary to some extent from year to year, as the occasional publication of a Circular containing all the regulations on some subject would enable the explanation to be omitted that was necessary as long as a number of clauses of different dates, bearing on the matter, had to be referred to.

I believe that the two instalments of Notes now published, with another very short one that I hope to prepare, will form a fair groundwork for such a manual, especially after they have been properly arranged and shortened. When the new Clothing Warrant is issued, and a system of accounts authorised, much explanation now required can be omitted: and I propose to then attempt the formation of a Manual, after which it will be for the Batteries to decide whether its annual issue would be of use to them.

Pay.

75. In matters concerning Pay, the Regulations practically used are contained chiefly in the Pay Warrant of 1st May, 1878, and the Financial Instructions of April 1879. The Secretary of State publishes his orders every month under the name of Army Circulars, the clauses of which alter, from time to time, all regulations concerning Pay, Clothing or Equipment, so that there is a constant alteration in process. To keep pace with these variations, all standard books of regulations must be interleaved when bound, and all changes in them must be noted as follows. For example, an alteration in the Finance Regulations is made by clause 223 of Army Circulars of 1879. Immediately on receipt, an entry is made in the first blank page of the Finance Regulations, in a list made for that purpose: "A. C. 223, of October 1879, Monthly Pay List Balance, affects paragraph 159." On the blank leaf opposite paragraph 159 is entered a note that A.C. 223, of October 1879, alters it, and the alteration is copied in, at the first leisure, on the blank leaf; a little tick being put against the original clause as soon as this is completed, to show that it has been attended to. At the end or beginning of each year an Index to the Circulars in force is published, with what purports to be a list, or addenda to the list, of cancelled Circulars. At present the detail of these cancelled Circulars will be found in the List published with Army Circulars of 1st January, 1878, and the addenda thereto published with clause 13 of 1878. At any time that notice is received that a Circular is cancelled the words "cancelled by clause — of 1879," or whatever year is given, are written across it. Thus, to get information on many points, an officer must first find out in the Index whether there is any Circular on the subject, and, if the Circular is found, he must make certain that no later clause, especially of the current year, has altered it. For example, the regulations for the married establishment are found in clause 165 of 1876, altered by clauses 47 and 79 of 1877; 60, 68, 170 of 1878, and 59 and 151 of 1879. The penalty for a mistake is forfeiture by the Major of any sum erroneously advanced; so that the position of an officer taking over a Battery whose Circulars have not been altered to date is not enviable. The difficulty of issuing the existing Circulars in one volume, and distributing them according to subjects, would not appear to be great. Messrs. O'Byrne of 18 Adam Street, Adelphi, have from time to time published useful volumes of the Circulars and General Orders actually in force; unfortunately they omit the appendices, which are often the most useful parts. It is hoped the list contained in paragraph 200 (not published with this series of notes) may be found useful; but no private efforts can really remedy the inconvenience of having to use as authorities a number of books containing circulars about one-half of which are cancelled. Practically, it is much the same as if for Bradshaw was substituted all the notices of alteration of trains issued by the railway companies for the last thirty years.

76. The Major obtains the cash required to pay his Battery as follows. In the beginning of, say December, he "estimates" on

W.O. Form 167 the amount he will require for January. He has so many men, and their full pay for the month comes to a certain sum; he will also have to pay at the end of the month some allowances to his officers and men, viz., lodging, fuel and light, and forage, etc. He may expect to have to pay some savings bank withdrawals, and for the last month of each quarter he has to estimate for the amount required to pay the postage, contingent, and repair of accoutrements allowances, and the grants for the library, and for the officers' mess. In the estimate for either April, May, or June, he has to provide for the charge for altering the annual clothing, see para. 116, inserting it in the month in which he expects to receive it passed. If by any chance the balance of the previous month was in his favour, its amount is included in his estimate. The good conduct pay and additional pay form separate items on the first page of the form; the latter is not included in the printed detail, so it may be overlooked.

77. The total of all these items gives the amount that might possibly be required, but there are certain to be considerable deductions. Some men will lose part of their pay by being fined, deprived pay, or imprisoned, etc. If any savings bank deposits are expected, these, as all other such receipts, will increase the Battery's income, and so reduce the estimate. In the last month of each quarter, allowance must be made for the return to Government of the deduction from the contingent for repair of arms, 3d. per rifle per quarter. If, as almost always will be the case, the last (November) Pay List showed a balance against the Major, that sum will be included among the deductions, a regular series of which has thus to be made. Experience and reference to past months will be the best guide: but the final result cannot of course be arrived at till the November Pay List is closed. By the Financial Instructions, art. 159, altered by A.C. 223, of 1879, the estimate should be framed so as to bring the monthly balance within Ten Pounds, but this is often too small a limit. For estimates, see Finance Reg. 76, 77, 80. The manner in which the Major wishes to receive his cash, generally in two instalments, on the 1st and 15th of each month, is filled in on the 4th page, round numbers being taken for the amounts, and the estimate is forwarded to the Paymaster in the first week of the month.

78. The first instalment for January will be received about 29th December, generally in the shape of a blank receipt forming a draft on the Accountant-General. Its receipt is at once entered in the cash account for December (see para. 88), or whatever month it arrives in. The second instalment arrives about 13th January, and is immediately entered in the January cash account. Each draft is at once paid in to the account opened, whenever practicable, with some banker in the Battery's name, on which the Major draws by cheque. For these Banking Accounts see Finance Regulations 92 to 103. The great object is to have little cash outside the bank, and usually from £5 to £10 covers any claims that may be made during the week that cannot be paid by cheque, except of course the weekly pay.

Where much cash has to be kept in hand a proper safe ought to be bought, and it would probably amply repay the Major to do so. On the weekly pay day a cheque is drawn for sufficient cash to cover all the payments of the day (para. 7). For every payment a receipt is at once taken by signature in the cash book if possible, or in the mess and pay books, otherwise by separate receipts that are filed. Many payments entered in the cash book, and duly receipted there, have also to be supported by separate receipts to enable them to be passed in the Pay List; forage allowance for example. These receipts should be obtained at the time of payment, and be either placed on a special file, or else in a portfolio kept for all the Pay List vouchers. The Major himself receives all sums paid to the Battery, especially savings bank deposits: inattention to this rule makes many frauds possible (see para. 94).

79. The Major accounts for the cash he has received as follows:— With the men, by means of the battery ledger and their account books. The Ledger contains all items of pay and allowances the men ought to receive: about these there can be little doubt or dispute; care only has to be taken that the same pay for every man is continued month after month that was entered in his No. 1 Report, or W.O. Form 97, when he joined the Battery, except when increased by promotion, two years' service as N.C. officer and grants of G.C. Pay; or diminished by reductions and loss of badges. Any mistake as to the date of such casualties will inflict loss on either the man or the Major. Against these credits go all the charges, each of which can be proved, pay issued and messing and washing by the mess and pay books, hospital stoppages by the roll, W.O. Form 152a, tailor's and shoemaker's charges by their bills, supported by the orders issued by the Pay-Sergeant to the man to get the work done, fines and deprivations of pay by the defaulter sheets, or W.O. Form 312 and 55, issues of necessaries by the necessaries ledger. As the ledger also contains all the entries of the man's savings bank deposits and withdrawals, it acts as a check on the S.B. ledger. The ledger is signed monthly by the man and by the Major, and its result, or the man's balance, is entered in his account book; and the entry is signed by the man, unless he is in credit, when the Major signs. When a man is in hospital, and has so missed signing his accounts, he should be visited in hospital, and got to sign his accounts there, so as not to have two months uncertified. Here note that the soldier's account book should never be taken from him; he should attend with it whenever any entry has to be made, otherwise he may plead ignorance of it if it tells against him, and he has not signed it.

80. The only other direct cash dealings with the men are the savings bank accounts (see para. 23 and 58). Here every item is supported by a receipt in the man's account book, the S.B. ledger, the S.B. Form No. 2 (W.O. Form 382), and the cash book, as well as the entry in the battery ledger. The man has in his book the Major's receipt for all deposits, and his acknowledgment of the

monthly state of accounts in the savings bank ledger in which the deposit appears, as well as the entry of the deposit in the battery ledger. The Major has the man's receipt for all withdrawals in the S.B. ledger, the S.B. Form No. 2, and in the cash book, as well as the entries in the battery ledger of all transactions.

81. Thus no question ought ever to arise about any transaction with the men, once the monthly settlement is completed, as long as the man is never allowed to sign a receipt in advance, and as long as no alteration, however well meant, is permitted to be made in an account after it has been signed.

82. There are other pecuniary transactions with the men that may be called "indirect." Some of their money goes each month in subscriptions to Battery Clubs, or to Funds (Cricket, Library, etc.), collected by means of stoppages entered in the ledger, while part of the cash of these funds is derived from subscriptions of officers, that is, from money that has never passed through the Pay List, and that is not accounted for to Government. For all these funds the Major is practically responsible; and he accounts for them by means of a Fund Book (para. 21). At the end of each month he has to carry from his cash book to the separate account of each fund, all the sums that have been stopped from the men on that account. These funds often have separate Treasurers who receive the money from the Major: but, while officers change so rapidly as at present, it is best for the Major to keep the cash himself. It would seem more correct for all officers' subscriptions, canteen grants in aid of any fund, etc., to be only entered in the fund book, and not to appear in the cash book, as they form no part of the Government money of which the cash book is really an account; but it seems probable that this point may be settled in an opposite sense by authority. Where the cash of the funds is kept with that of the battery, their cash balances would appear in the battery balance sheet (para. 14 and 89) as debts due by the battery.

83. With the Government the Major accounts by means of his Pay List, W.O. Form 1075, now to be replaced by W.O. Form 357 with 356. These forms are not necessarily complicated, but at present they are so by the number of different rates of stoppages and allowances. Practically the system is this: the Major takes credit for all pay, G.C. pay, additional pay, S.B. withdrawals, all allowances, and all claims against Government, including any balance in his favour in the last Pay List, or in the observations thereon. He debits himself with all the cash he has received from Government, all S.B. deposits, and all amounts recovered from the men, by means of stoppages, for imprisonment, deprivation of pay, fines for drunkenness, hospital stoppages, or cost of clothing or necessaries, militia stoppages, as well as any balance against him in his last Pay List, or the observations thereon (para. 87). The whole of the Government charges for or against the men are shown

in detail against each man's name, and are afterwards massed. It is unnecessary to describe such a number of forms as a Pay List now contains. Practically the great point is to be certain that the proper pay only is drawn for each man, the rate being given when the man first joins you by a No. 1 Report, or a W.O. Form 97, received from the Paymaster, to see that no improper increase is made, and that all stoppages are carried out. This sounds very simple, and ought to be so in practice: a little reform in allowances and stoppages would sweep away half the difficulties that every casualty of a soldier now causes. Great differences naturally exist in the manner in which Pay-Sergeants prepare their Pay Lists. Some clerks work almost entirely by the List itself, entering every casualty and variation at once therein, so that little has to be done at the end of the month; others trust more to the preparation of the Vouchers, entering all alterations in the List when the month is finished. A rough journal is sometimes kept, in which all occurrences that either do or that eventually may affect the Pay List are entered in pencil on the report of the Battery Orderly. Great freedom of action should be allowed on such points. All that is absolutely necessary is that immediate permanent record be made of every casualty affecting the Pay List.

84. Here note that the term "Debt of the Battery" is often used in three senses: 1st, as the total of the debts of the men to the Major; 2nd, as the debt to Government on the Pay List when closed; 3rd, as the debt on the balance sheet, that is, the difference between the liabilities and assets when the liabilities exceed the assets. The last is the true meaning, and it is only when there is a debt on the balance sheet that the Battery can be said to be in debt.

85. The charges in the Pay List have to be accounted for by a mass of so-called "Vouchers"; a list of those ordinarily sent is given in the next paragraph, but they vary a good deal with different Paymasters, and the new Pay List will probably strike a few out. Some are real vouchers; thus the Hospital Stoppage Roll, prepared by the Surgeon, is an actual check on the Major's statement in his Pay List of the number of days in hospital, but in many cases the voucher is really a repetition by the Major, on a different piece of paper, of a statement already made by him in his Pay List; the form for men fined, W.O. Form 55, and deprived pay, W.O. Form 312, are examples of obsolete survivals of checks; and batteries can accidentally or intentionally defraud Government of money by omitting to report in the Pay Lists some of the men deprived pay, or fined. Practically half the vouchers are useless, and therefore injurious, the Muster Roll being the most useless of all. A simple Adjutant's certificate is accepted to prove that a man has been a certain number of years clear of the Defaulter Book; but all the details of his service must be set out every time he gets a badge. Why not accept a short certificate from the Record Office that a man has a certain amount of service? For vouchers see Finance Regulations, paragraph 187 to 195.

86. *Pay List Vouchers.*

W.O.F.	SUBJECT.	W.O.F.	SUBJECT.
180	Muster Roll.	56	Alteration of Clothing.
	Orders for Promotion (copies).	624	School Pay List.
120	Grants of G. C. Pay (Adjutant).	382	Savings Bank Deposits—Withdrawals.
361	,, ,, (Service).		
124	Restoration of G. C. Pay.	80	Return Court Martial.
361	Increased Pay N. C. Officers (Service).	312	Mulct Pay.
		55	Fines.
619	Re-engagement Schedules.	121.	Forfeiture G. C. Pay.
342	Routes.	284	Soldiers confined to Guard Room.
1071	Travelling Claims.		
84	Allowance Discharged Soldiers and Families Deceased Soldiers.	910	Soldiers confined in Prison.
		255	Cell Return.
			Militia Stoppage.
279	Allowance Plain Clothes (Discharged).	152	Hospital Stoppage Roll.
		177	Stoppage Public Property.
772	Ration Allowance Families separated.	192	Non-effective Accounts—Statement.
1653	Ration Allowance, Rations not drawn.	190	Non-effective Accounts—Inventory.
	Authority for fresh grants of ditto.	606	Clothing or Necessaries sold (Sub-Voucher).
1112	Lodging Allowance.	611	Necessaries sold.
1436	Fuel and Light.	617	Clothing sold.
111	Forage.	1220	Delivery Voucher Stores issued on payment.
904	Postage. Q.		
	Copies of Telegrams.	909	Ration Certificate (Commissariat).
	Receipt Payment Parcels.		
	Receipt Officers' Mess Allowance. Q.	102	Rations drawn, attached men.
		102	,, ,, detached ,, by other Batteries.
	Receipt Contingent, Library, and Repairs of Accoutrements.	194	Hospital Orderlies in receipt of dues.
857	Marking Recruit Kitts.	140	State of Arms. Q.

N.B.—Duplicates of all receipts sent to the Paymaster, and duplicates or copies of all important vouchers, should be retained by the Battery whenever practicable.

87. The Battery retains the copy of the Pay List on which the actual calculations are made, and a fair copy is prepared for the Paymaster. Of course a great part of the clerical work, names of the men, the married establishment, etc., can be prepared in advance. Note that all copies of calculations must always be proved, just as if the totals were unknown; clerks are very apt to copy a column of figures, inserting the correct total, but omitting one or two items that make the amount. When completed, the Pay List is sent, with all the vouchers, on the 5th of the month, to the Paymaster, who sends back, on the completion of his audit, his observations (W.O. Form 203). These are at once answered on the form and returned. The Paymaster now completes his audit, filling in the column "Result," and he returns the observations to the Battery, who retain them. It will be found convenient to bind the Pay List with the observations thereon, roughly but strongly, say

every year or so. All disallowances, or increased allowances, resulting from the observations, must at once be entered in the balance sheet, and should be immediately recovered or carried out. Thus the Paymaster may disallow two days' pay for Gr. Smith, for 10th and 11th January, as he was then in the pay of another battery: this makes a debt on the balance sheet to the Paymaster, covered on the other side by a credit to the same amount due from the man, or from the other battery, as the transfer ledger sheet may show him paid by them for those days or not; and recovery of the amount is made as soon as practicable. Or the Paymaster may point out that G. Brown ought to have been given G.C. pay from 18th, not 19th January, and he therefore allows another penny: this is at once carried to G. Brown's credit in his February ledger sheet, and entered as a credit in the balance sheet from the Paymaster, covered by a debt on the other side to the man. The Battery may, of course, sometimes suffer actual loss from disallowance, as it would in the case given above if G. Smith had been discharged, having been twice paid for the two days before the receipt of the observations; but ordinarily the observations do not alter the Battery's balance. The Battery is only shown to owe so much more or less to the Paymaster than was shown in the balance in the Pay List, and the same sum (the difference), more or less, to the men or to other persons. All actual irrecoverable losses should be paid up by the Major as soon as they are ascertained. Many mistakes are made on the points dwelt on here.

Cash Book.

88. The Major keeps an account of all his cash transactions by means of his Cash Book, which is fully described in paragraphs 2 to 8. The form may be altered by inserting columns for cash transactions with the Pay-Sergeant. This book is the foundation of the system of battery accounts; any neglect of it is fatal, while if it is kept up all complications can be eventually unravelled. One point may be noticed here. Much misunderstanding seems to exist as to what is called keeping the cash accounts for each month separate. A good deal might be said for separating the cash, only it is impossible to do so. For example, the credits of all men not paid up on the last of the month are carried on to the accounts of the next month, so that the cash must be mixed sooner or later. Again, the canteen bill for the last week in December cannot be paid till January, and it will frequently happen that a cheque for the January account has to be drawn early in January before the cheque for the canteen is drawn, so that No. 1 cheque will be for January, No. 2 for December. Again, to take a real instance at this present time, the Paymaster calls on me in August 1879 to remit an account overdrawn in October 1878: this sum will be paid by the Battery in October 1879, and will be recovered from an officer in India in or about December 1879. Can all these items be entered in the cash account they really belong to, October 1878? Again, if a Major finds himself £5 short on 31st October, will he require a fresh remittance from the Paymaster, while he has a cheque for £180 or £200 in his possession? Let any one who believes in

the possibility of separating the Cash for two months, thoroughly examine any one of the advocates of the separate system: he will find that no battery does, or ever did, keep their cash for two months really separate; that all cash received is put in the same bank, or in the same safe, and is drawn on as a lump sum for any month; that no battery opens a separate account for November, closing that for October; in a word, that the separate system only exists in name, not in fact. The worst of the "separate" myth is that it constantly leads to cheques being wrongly dated, in an attempt to make it appear that a sum really paid on the 3rd November out of the total cash of the battery was paid on 31st October out of the October cash. The separate system is totally imaginary, at variance with the facts, and causes great confusion in the banking accounts if the cheques are rightly dated. The real explanation of the wish to adopt the system is that many officers are not used to work by means of a balance sheet, and so do not understand that it will correct the apparent surplus of cash produced by the instalments of pay being put down as received, and they are frightened lest the large amount of cash in hand may expose them to fraud. Once it is customary to carry on a large balance of cash, these difficulties disappear; and if the cash is really received, it is surely wise to record it in the manner that makes it easiest to watch it, and not to have to refer to two accounts to find out how much cash you have.

Balance Sheet.

89. Having so many different accounts with so many persons, owing so much to Government, so much to his men, and having so many people in debt to him, the Major requires some test of his actual position when all these debts and credits are brought together. This test is supplied by his balance sheet, made out monthly as described in paragraphs 14 to 20. If honestly made out any error will at once be brought to light. The two most important points to see to are that no debts are omitted, and that all so-called credits are really recoverable and admitted by the person from whom they are claimed. The result of the various audits, the monthly one of the pay, the annual one of the clothing (para. 169), and of the equipment (para. 199), ought to prevent the Major mistaking his position with the different departments. The items easiest overlooked are the debts of deserters or of deceased men not paid up by the Major, and therefore improperly increasing the debt of the Battery by throwing on it the debts due from the Major; and any proceeds of sales of clothing and of necessaries not duly credited to Government, and so improperly increasing the credit of the Battery. This last omission may by ignorance or fraud be made to conceal a real loss or deficiency of a similar amount.

90. The Major, however, is still exposed to a second audit of his Pay List at the War Office, the result of which, starting fresh objections, may not reach the Battery for six months, or even much later. In fact,

at present, the audit by the Paymaster is of little practical use to the Major, and forms no safeguard to him. This is a great hardship, and easily remediable.

91. Here note that the "observations" of the Paymaster are the recognised and sole proper means of correcting the Pay List. Paymasters sometimes wish to avoid the use of the "observations" by getting the duplicate copy of the Pay List into their own hands, making any alterations they desire in it, and then returning it to the Battery without explanation. When this is done, all control of the battery finance passes from the Major; and, if he allows it, he need trouble himself little about any details. A small note on the old printed form of the Pay List, W. O. Form 1075, that the duplicate copy may be called for if "necessary," used to cover this system: the real object of the note is that the duplicate may be called in when the original is found to be so full of errors that it would be difficult to correct it by the "observations." The duplicate Pay List is the property of the Major, it is his sole record of his financial transactions with Government, and it should always remain in his custody, except in the case contemplated by the note, when it is so incorrect that it ceases to be of actual value to him. The pecuniary responsibility of the Major gives him certain rights; and, above all, that of retaining the records of the whole of his transactions. This is often forgotten when books are called into Brigade Offices for inspection. The position of a Battery in which both Pay Lists, sent by the same post, have been lost, would be disagreeable, especially if a change of Pay-Sergeants took place at the same time.

92. Officers new to command will probably be very anxious about their cash, in which they think they are most likely to incur losses, while, in reality, the money is much easier to look after and to check than the stores. There are, however, many ways in which the Major may lose money: first, there are the really unavoidable losses, men dying, deserting, or being discharged in debt. (If two men desert, one two pounds in debt, the other two pounds in credit, the Major has to pay the debt and the Government takes the other man's credit.) Next come the nominally avoidable losses; payments to men about to be discharged, believed to be correct, and passed by the Paymaster, but disallowed on audit by the War Office; over-payments for carriage of baggage, railway and passage warrants not issued by the cheapest route for men discharged, debts of men suddenly transferred, eventually irrecoverable, and other items, many of which can hardly be avoided as long as the system exists of requiring prepayment of a claim before it is audited. Then come the really avoidable losses; payments to men not entered in the ledger, charges for necessaries and clothing, and tradesmen's bills omitted from the ledger, savings bank withdrawals not entered, debts of transfers permitted to drop, credits of transfers not claimed, disallowances on audit not recovered from the men or from the Major, deprivation of pay and fines not charged, letting discharged men, especially from detachments, leave without getting full receipts, besides losses that may occur from over-drawing rations, losing or over-issuing

or not withdrawing clothing, losses of belts not charged, damage to accoutrements not charged, etc.

93. The vagueness and frequent alterations of the Pay Regulations are a constant source of trouble and loss, as is also the total practical removal of pecuniary responsibility from Paymasters. It would seem only right that, if the issue of any allowance is once passed and approved by the Paymaster, the appointed agent of the Government, any subsequent decision of the War Office should not affect the Major; and the amount disallowed should only be returned if it can be recovered from the recipient. It is practically impossible for the Major to refuse to pay any allowance declared by a Paymaster to be due to a man about to be discharged, but under the present system he may, a year afterwards, have to himself pay the sum on some fresh War Office decision.

94. As for losses by dishonesty or fraud, there are numberless ways in which the Major can be cheated if he does not retain the actual control of the cash. Diminishing the real amount of savings bank deposits, or increasing that of the withdrawals (not in the men's account books, but in the Pay List and Form No. 2), selling necessaries or clothing without crediting the charge, increasing the amount charged for tradesmen's bills beyond the real sum, are instances, besides the manner in which Government, or the estates of deceased soldiers, may suffer from false entries of tradesmen's bills or other items in the accounts of men deceased or deserted. Almost all these cases of fraud are stopped by the Major retaining the real practical control of the cash: his doing so removes the object of altering figures, or concocting charges: while no checking or auditing can prevent fraud on the part of the person having the practical disposal of the cash. Discovery will, it is true, in most of these cases, eventually take place; but in the meantime large sums may be lost. For example, let us take the case of a battery in which three pounds worth of clothing or necessaries have been sold, and the amount recovered from the men; but, by error or design, not credited in the Pay List. If the Major has a proper hold on the cash it remains in his hands; and on striking his next balance sheet he finds himself suddenly three pounds in excess of his proper credit, and knows some error has been committed. If, however, the Major is careless of the cash, a dishonest Pay-Sergeant has only to manufacture a corresponding charge in his cash account; the balance sheet gives no sign, and the fraud would remain undetected for perhaps a year. If the whole of the money that is spent in paying the Artillery were added up, all the avowed payments to clerks, and all the losses, a very large amount would be reached, a great part of which could be saved by a simple system of accounts, quick audits, plain regulations reprinted annually, granting batteries proper safes, and, above all, by proper care of the cash.

95. There is naturally a strong wish among many officers for the introduction of some system which would give them perfect security in their financial transactions. There is one system, partly adopted in the

Infantry, and which is so perpetually being rediscovered in the Artillery, that it ought to be mentioned here. It may be called the cross-totalled system; and in practice is simply that all the items that go to make up a man's ledger sheet, that is, all the items of pay and allowances and all the items of stoppages, are placed horizontally across the top of a large sheet, ready ruled and printed with the necessary headings. The names of all the men are placed vertically below, and each man's account is entered against his name, and read off horizontally. Columns are provided for the totals of all the credit and of all the debit items, and for the balances. Every column is totalled at foot, and all the totals should agree when totalled vertically and horizontally. Thus it can be easily seen whether any item granted or stopped has been distributed properly. For example, if the total at the foot of the column for stoppage for necessaries is really the correct total of all the stoppages from the men on that account, and really agrees with the value of necessaries sold, and with the value credited in the Pay List or paid to the supplier, then the Major is safe from loss on that item. If a pair of socks issued to G. Brown has not been inserted in his account, while it has been added in the total of stoppage for necessaries, the omission will be detected by that column not totalling. Again, if the grand total of all the proper credit items equals that of all the debits, with the balances, the Major is safe from loss on the men's accounts. No other system promises such good results: unfortunately it is very difficult to carry out, and very misleading. Where it can be honestly prepared, it is one of the best checks, as it not only shows if there is a mistake, but generally localizes it. It requires, however, very good clerks, as alterations or blots, that matter little in a small ledger sheet, are very confusing with long calculations. If the ledger is used as well, this sheet is all extra work, useless if the accounts are right, and very apt to show errors which only exist in itself, not in the actual accounts. If the ledger is discarded, a great practical difficulty at once arises as to the horizontal totals of each account, which are otherwise checked by those in the ledger. Very few people are able to add a long horizontal line of figures, and a single error makes the sheet valueless, and may cause hours of work. When such systems can be watched under the ordinary casualties of the service, they will be found to break down just at the moment they are most wanted as checks. Modified application of the system is often very useful in quiet times; and it may be a valuable auxiliary to a simple system, always, however, bearing in mind the considerations urged in para. 97.

96. Captain Turbull's system of "Proof" appears to practically amount to putting all the gross items drawn for the men against all the gross items of stoppage and pay issued, and their balances, the total only of each item being given. The result will indicate any error, just as the ordinary balance sheet will, with only this advantage, that a variation in the balance sheet shows an error somewhere; while in this system it would be evident whether it was in the men's accounts; the precise item, however, not being denoted. Thus, in the case of G. Brown's socks, given in the last paragraph, if the gross item "necessaries" was taken

from an amount correctly credited to Government, an error or deficiency of the value would be shown, in the balance sheet as somewhere in the battery, in the Proof as somewhere in the men's accounts. If, however, the gross item "necessaries" were taken from the actual recoveries, then, if I understand the system rightly, the Proof would give no sign, as the overissue of pay would in the men's accounts cover the loss, so that in this case the men would be protected, not the Major. A peculiar cash account and special rules have to be adopted, causing, I think, the abandonment of certain practical checks for a very small advantage, if, indeed, any one is really protected by the Proof. No book appears to exist on this system that would at once show the cash received by the Battery or the cash in the actual possession of the Major, unless he invariably keeps every penny in the bank or in the hands of his Pay-Sergeant; so that it would require two books to show the whole receipts and expenditure. Great reliance appears to be put in the bank book, which must be often away from the Battery.

97. All adopters of systems of any sort, simple or complicated, must be warned that not the slightest security from fraud is given by any form of accounts. The more complicated the check, the more it depends on the accounts not being cooked; while cooking accounts is the easiest thing possible. In any system, if all the items are correct in amount there is little loss to fear, while a single false entry would make every system useless. The practical difficulty with many officers is that they are not content to trust to a bald statement of their Pay-Sergeants as to the payments, while they are not prepared to go fully into the accounts. In either system described in paras. 95 and 96 all depends on the totals being correctly arrived at and on the items being the real amount. If an officer is not prepared to go carefully into these details, if he is prepared to accept any figures, he may just as well take them in a plain form. Most officers have, or give, only a limited time to verify their accounts; that time will be best employed in checking the accounts at first hand, checking the ledger sheets themselves, and, above all, in watching over the cash and the cash payments. There are two steps in almost all the frauds a Major has to fear: first, the alteration of some item on paper—this he practically can hardly ever prevent; the next step is to get hold of the cash—this the Major can easily prevent. For example, one battery lost about three hundred pounds in their Savings Bank accounts, the operation lasting some years. The cross-totalling of the Savings Bank accounts offered no hindrance; and I fail to see how any mere system of accounts could stop such frauds. A gunner withdrew £1 from the bank; the Pay-Sergeant withdrew £10, and produced the necessary receipt for £10; all the accounts totalled, all the vouchers were present, and all would have certainly passed the "Proof" or "cross-totalled" systems. The practical check of seeing the cash paid to the man was not applied. The same remark will hold good for all the common frauds; for example, inserting false charges in accounts of deserters. If they are inserted, how is any one to get the cash if that is properly watched over? Let any Major consider his own position: he is surrounded by a number of paper checks on every

one of his financial transactions. Are not all these checks practically useless for their real object, and only of value because he is acting honestly? You cannot by paper checks control the person that has the practical use of the cash. You may ensure ultimate detection, but that is the last thing that clever fools who commit frauds fear. Officers often say that they used to lose money till they adopted such and such a system; the truth being, I suspect, that the attention incidentally called to the cash by any system is what really stops the loss. The accounts will always take very long to check; the payments, in a service battery, hardly take any time to check. Look after your cash, and you need fear little about your accounts.

Clothing.

98. The Clothing Regulations can scarcely be said to exist at present in any tangible form. The old warrant of 1865 has been altered and re-altered by a number of Army Circulars; while manuscript letters have lately been used as the form for communicating important decisions. The following letters appear to contain the latest regulations: P. C. No. a. R. H. A. 512 of 8 March, 1879; P. C. General No. 2911 P. C. 19 Hussars. 474 of August 1879; and another letter of the same General No. dated 1 February, 1879. For Foreign Stations, see para. 173 of these notes. A new warrant has long been expected and may be out soon. In the meantime Majors have to be most careful as to how they act, and had better refer any case that admits of the slightest doubt for special decision, not trusting to settlements of similar points with other batteries. The mode of working in each battery varies in clothing matters so extraordinarily that it has been difficult to define any system; but I trust these notes will be useful even if the warrant appears this year.

All correspondence about clothing is addressed to The Director of Clothing, Royal Army Clothing Depôt, Grosvenor Road, London, S.W., and must be written on the left-hand margin in duplicate. It is strange that our departments vary in their choice of margin, and the use of the duplicate letter is not apparent, as the department returns it, in case of any question being asked therein, with their reply on the margin. The department do not follow this duplicating rule themselves, probably finding it useless and inconvenient; and I notice that while a similar rule exists for internal correspondence in the Ordnance Store Department (para. 828 of their Regulations), a similar exception is made in favour of the head office. We may therefore assume that the copying of some thousands of letters annually could be dispensed with by an alteration of this system. In these notes, for brevity sake, the department is called "Pimlico."

99. All articles of clothing, that is, head-dresses, helmets or busbies, tunics, patrol jackets, pantaloons, overalls, trousers, Wellington, knee, and ankle boots, cloaks and capes, great-coats, and capes, and leggings, spurs for knee-boots, gloves for mounted men, plain clothes for dis-

charged men, are obtained from the Army Clothing Depôt. Regimental necessaries, that is, every article that makes up a man's kitt (except Bibles and Prayer Books supplied by War Office, see A.C. 157 of 1876, para. 27 to 29), can also be obtained from the Clothing Depôt, as well as sea kitt necessaries. The issues of clothing are divided into annual and biennial. The annual issues are, on the 1st October a pair of ankle-boots; on the 1st April a patrol jacket, a pair of trousers, and on each alternate year a pair of ankle-boots. The biennial issues are a tunic, a (second) pair of trousers, and a pair of Wellington boots on the 1st April of each alternate year. Thus in two years a man receives one tunic, two patrol jackets, three pairs of trousers, three pairs of ankle-boots, and one pair of Wellington boots. There is a curious nomenclature for the April issue of boots, the Wellingtons being described as a "biennial issue, made once in two years"; the ankle-boots being called an "annual issue, made once in two years." On first joining, a man receives a head-dress, great-coat, cape and pair of leggings, to last 4, 5, and 3 years, respectively. All these articles are issued free of charge (except for marking the clothing, see para. 116), but have to be kept in proper repair at the expense of the men; and must all be eventually returned to Pimlico, the men being chargeable for any loss or damage not due to fair wear and tear. A recruit also receives a complete set of regimental necessaries, issued free of all charge, which he has to keep up at his own expense all the time that he serves; but these articles, and those he buys to replace the first issue, are technically his own property, and on his discharge he can dispose of them at his own pleasure. Special issues of clothing are made to recruits: see para. 137. All the articles for these requirements have to be demanded, received, stored, issued, cared for, kept up, received back and accounted for by the Major. Packing cases received with clothing and with W.O. Forms have also to be accounted for to Pimlico: see Army Circular 113 of 1876.

Demands, Clothing.

100. The Major gets his supply of clothing as follows. The clothing year begins on the 1st July, at which time his annual demand is due. The demand had better be divided, that for the October issue of boots being first sent in. All articles of clothing, boots included, are made of different sizes, so as to fit men of certain height and chest measurement, and of certain length and width of foot. This is at present so well done that little alteration is required in the case of most men, if fitted with their proper sizes. Ten per cent. of the garments (not boots) may be demanded "in material," that is, cut out, but not made up, to meet the cases of men of exceptional sizes. A list of the sizes, and of the men for whom they are suited, is given in W.O. Form 1314 for garments (tunics, jackets, trousers); W. O. Form 305 for boots; Army Circular 159 of 1878 for helmets; and W. O. Form 130 for great-coats, capes, and leggings.

101. The first thing is to ascertain what men will take their discharge,

or intend to join the Army Reserve before 1st April, 1880; all the rest except recruits just enlisted (see para. 137), will be entitled to ankle-boots on 1st October, 1879. Then for the April issue, the men who will take their discharge before the 1st October of the next year, 1880 in this case, or that intend to join the Army Reserve in the June quarter (Army Circular 154 of 1876), are not to receive any new clothing on 1st April, 1880, though they may be given "part worn" articles (para. 152 of these notes, and paras. 6 and 7 of letter P.C., General No. 2911) if the Major thinks fit. A list prepared in accordance with para. 69, corrected to include discharges, will give the names of these men: all the rest, except recruits (see para. 137), will be entitled on the 1st April to a patrol jacket and a pair of trousers, as well as a pair of ankle or Wellington boots, as the case may be. Those men who have not had a tunic for two years, say a man who got a new tunic in April 1878, will get a tunic in April 1880: the same rule holds good for the second or biennial pair of trousers. What each man is entitled to is easily determined in the case of men present with the battery on the last 1st of April, or recruits since clothed by the battery, by reference to the nominal roll in the clothing ledger (para. 167); in the case of transfers, by reference to their clothing transfer returns (paras. 27 and 141), which show what they have received and up to what date it has to last. The detailed account (see paragraph 171) is the best guide. You thus get the total number of articles required.

102. It must rest with the Major whether he chooses to make provision for anything besides the wants of the men actually present. Recruits may perhaps be expected to join unclothed, some deserters may rejoin; but as a rule the Major will try to have as little surplus clothing on hand as possible. Some consideration will have to be given to the cases of Corporals and Sergeants whose promotion may be expected. See paragraphs 14, 15 and 16 of letter $\frac{\text{P. C.}}{\text{General No. 2911}}$ as to these men, and para. 144 of these notes.

103. The sizes that each man will require should be found by reference to the size roll (para. 26), except that as the demand is made for clothing only to be issued in April, and then to last practically for two or three years, some allowance must be made in the case of the younger men, boys, and recruits, for their growth and filling out. Special care should be taken about the boots, and the men should be made to go to the office to see that they are down for the sizes they really want. Recruits in particular will probably have found that some alteration of size is required from that of the boots originally issued to them. Men occasionally like different sizes for their Wellington and for their ankle boots.

104. It must be remembered that the tunics and patrol jackets will be supplied without any badges or numerals, etc., so that the demand must include all the chevrons, G.C. badges (gold for N.C. officers, worsted for men), guns and crowns for sergeants, trumpeters'

badges, skill-at-arms badges, artificers' badges, brass numerals, pins, plates and grenades, required not only for the April issue, but for the whole year. The laces for the ankle-boots are not demanded separately, but are included as part of the boots. The brass belt hooks for tunics and jackets are supplied on the garment as part of it.

105. The demand for boots is prepared on W.O. Form 305 in duplicate. On the front is a size roll, but this does not give all the minor variations, of which there are four of each "size"; thus, 7^1 7^2 7^3 7^4, the "fours" being largest; but for some reason these minor sizes may not be specified. The demand is sent in to Pimlico and a copy filed by the battery. The receipt of the demand is acknowledged from Pimlico, otherwise inquiry must be made. Particular attention must be paid to the number, called the P.C. number, inserted by Pimlico on their acknowledgment, as this has to be quoted in all after references to the batch of clothing supplied under its authority: for example, the claims for marking and altering all this consignment are only passed on the P.C. number being given: see paras. 116 and 145.

106. The demand for garments for the April issue is prepared on W.O. Form 81, in duplicate, with a size roll, W.O. Form 1314 in triplicate: separate size rolls (1314) are required for material suits. The boots, Wellington and ankle, for the April issue are demanded on W.O. Form 305, in duplicate, as for October. Copies of all the forms are kept by the battery, and the demand is sent in, and its receipt acknowledged as for that for October.

Demands for plain clothes for men about to be discharged, except for those discharged as bad and worthless characters, with ignominy, or for fraudulent enlistment, are made out on W.O. Form 310 in duplicate, and sent in a month or so before the date of discharge. See para. 140.

Demands for "Material and Garniture" (cloth, etc.) that may be required on payment, for any purpose, are made on W.O. Form 308, but when the goods are received they are not brought on charge or accounted for: payment for them being made, in the same quarter, in the Pay List.

107. In due time the packages containing the clothing arrive. No charge is made for delivery: when any charge is made for other stores delivered, the amount is paid out of the battery cash, and recovered in the postage account. The packages are carefully examined to see that there are no signs of their having been opened. The weight is usually marked on the cases, so that if they are weighed and found to be light, the fact of their having been tampered with may be discovered. The "carrier's note," W.O. Form special 138, a mere acknowledgment of the receipt of a certain number of cases, generally received from Pimlico before the cases themselves arrive, is signed, if all is correct, and sent to the address of the carrier given on it (see para. 130, end). As soon as the regular vouchers, Receipt W.O. Form special 503, and Delivery W.O. Form special 505, arrive from Pimlico, application is made for a board of survey, and the cases are only opened

in the actual presence of the board, the contents counted and carefully examined by a tailor and a shoemaker, and compared with the sealed patterns, one of which is generally sent with each large consignment. To insure the articles being the sizes marked on them, a certain number of each, say five per cent., are temporarily fitted on men of corresponding sizes. If there is any damage or deficiency, or if the articles do not come up to the sealed pattern, a report of the board on W.O. Form 620 is made to the officer assembling the board, and forwarded to the Director of Clothing. The Commanding Officer forwards to the General Officer Commanding the District an extract on W.O. Form 223, with his observations (the extract is sometimes prepared by the battery); the General Officer forwards this with his opinion, after investigation, to the Adjutant-General (see A.C. 112 of 1875). Any damage or deficiency that may exist, and that is not now discovered and reported, has to be made good by the Major, so that it is for him to see that the board of survey do not pass lightly over the examination. If all is correct the proceedings of the board are entered on W.O. Form 620, in the War Office Book 106, kept for that purpose, and a separate Form 620 is sent to Pimlico, countersigned by the officer convening the board. All the articles received, not only the clothing, but also the cases, barrels, canvas coverings of parcels, etc., are now brought on charge, and their receipt is duly entered on pages 3 and 4 of the clothing ledger (para. 149), care being taken that the details agree with the receipt voucher, except the garments received in material, the invoice of which enumerates all the little items making up each garment, while in the ledger they are only brought on as so many garments, "tunics," etc., a note "in material" being added. The receipt voucher, W.O. Form 503, is compared with the delivery voucher, signed and returned to Pimlico. The delivery voucher, W.O. Form 505, is fastened by strong clips to the inside of the clothing ledger at the beginning. All the articles are now entered in the clothing stock book (para. 25 B) as "received," except the cases and barrels, which can be accounted for satisfactorily in the ledger. The whole consignment is now in the charge of the Major, who has to answer for them until they are returned to Pimlico. For the nature and degree of his responsibility, see para. 145.

108. The October issue of ankle-boots is made on and after 1st October by the men coming to the store, and, under due supervision, fitting themselves, as real or imaginary differences exist between boots nominally of the same size. Once the man is satisfied, the boots are marked by the storeman with the man's number, that of the battery, and the date of issue, by means of iron stamps supplied by Pimlico (see A.C. 15 of 1880). The issue to the man is entered in the clothing stock book (para. 170), and in the man's account book, and in the detailed account (para. 171) before the man leaves the store with the boots; the man signing the last two entries. The next pay day each man brings his book to the Major to have the entry signed by him, and compared with the stock book. This is a good time to have the issue also entered against each man's name in the nominal roll in the

clothing ledger (see para. 163). At the end of the month all the men's books are again inspected to see that the issue is complete, the attendance of the men being checked either by the Pay List or by the nominal roll, and their presence being insured by the plan described in para. 72. A list is made of any men not fitted from being on detachment, in prison, etc., and this is attached to the ledger for after reference. For marking, see R.A. Orders 79 of 1876, pages 18 and 19, and A.C. 15 of 1880.

109. When the October issue is practically completed, the boots that were issued the previous October are called in. That issue has completed its term of wear, but the Major may allow any men to retain their boots a year longer if they like. The best plan is to call all in to be examined, and to let any man have his boots back if he likes; this insures their being in existence, and most will be given up willingly as useless. The receipt of each pair is entered in the clothing stock book, and in the detailed account. It is well after this has been done to attach to the ledger, or insert in a page of the stock book, a list showing the names of each man who received the original issue (in October 1878 in this case), and what has become of each pair, whether returned into store, taken away on transfer, or on discharge, or left in possession. This may save much trouble hereafter, unless a detailed account (para. 171) is kept. Boots made away with should be specified (see para. 168).

110. The fitting and alteration of the April issue take some time, but if begun too soon much of the work done may be rendered useless by men being transferred away. The duty men are first fitted, employed men, corporals close to promotion, etc., being left to the last. Enough men to give the tailor about a week's work are sent to the store and fitted according to their sizes shown in the size roll (para. 26), the clothing being if possible arranged in bundles according to size. Each man gets his patrol jacket and annual trousers, and if entitled thereto, his tunic and biennial trousers, goes to his room, dresses himself in one suit and parades before the Major, first with, then without his waistbelt. The tailor marks on the garments the alterations ordered by the Major, the Pay-Sergeant notes the required alteration in a book, the "alteration sheet," kept for that purpose. As soon as one suit is fitted the man dresses himself in the other, if he has one, and parades again to have that fitted.

111. The faults of the clothing, as well as ideas as to what looks well, vary from year to year, but it will always be important that the man should have plenty of room for his chest and throat. The older men will generally take care that they are at least comfortable, but young soldiers are apt to try to get clothes too tight for them to march and work in. The old mistake, that a foot soldier ought to have his trousers loose round the ankle, is now pretty well exploded.

112. After the first fitting it ought to be certain that the suits issued

will eventually fit the men that have them, as any garment obviously wrong is changed at once. The men now bring back all the garments to the store, and give them to the Pay-Sergeant, who, as he receives them, writes each man's name on the patch of linen put for that purpose on the breast of the tunics and jackets, and on the pocket or lining of the waistbelt of the trousers. All this lot of clothing is then sent to the tailor's shop, the articles "passed" to have the breasts padded and the chevrons, badges, numerals, etc., put on, the others to have the alterations carried out. Small alterations often need not delay the completion of the badges, etc. With the garments, the Pay-Sergeant sends a list of the articles, the names of the men, and the work to be done. The badges, etc., required are sent to the shop with each lot, or else are handed over in gross to the tailor, who accounts for them after the whole issue is completed. When more than one battery uses the same tailor's shop articles are apt to get astray, and the less kept in the shop the better. When this batch of clothing is returned by the tailor, the men parade, and are inspected as before, but this time with all the "past" articles completed. The clothing is again returned to the Pay-Sergeant, who hands over to the storeman all articles finally passed to be regularly marked with the man's number, name, battery and date of issue; this is done with wooden types provided by Pimlico for the purpose. For payment for marking, see para. 116. The clothing is then kept in store till 1st April. For fitting clothing, see clause 140, Army Circulars of 1876. For marking, see R.A. Orders 79 of 1876, pages 18 and 19, and A.C. 15 of 1880.

113. The boots for the April issue are fitted and marked in the same manner as those for October, but are retained in store till 1st April.

114. On the 1st April all clothing ready is issued, each man attending, with the Sergeant of his division if possible, receiving his full clothing, boots and all, having the issue recorded in the clothing stock book, the detailed account, and his account book, and signing the entries. If practicable, the issue is also recorded at the same time in the "nominal roll" in the clothing ledger, against each man's name (see para. 163). It is well to issue the full clothing of each man at one time, whenever it can be done without delaying the issue too long. If this cannot be arranged it is best to leave the issue unrecorded in the man's book till it is complete; or to record it in two entries: anything except altering the entry after the man has signed it. What with men coming from hospital, prison, etc., the issue goes on all April, and often much longer. On each pay day in April the Sergeants make the men of their divisions who have received their clothing during the week bring their books to the Major to have the issue certified after the entries in the clothing stock book, the clothing ledger, the detailed account (para. 171), and the man's book have been compared. On the 30th April or 31st May all the men bring their account books to the office, and their attendance is checked by the "nominal roll" in the clothing ledger, to insure that the full issue is recorded,

particular attention being given to the entries of the biennial articles, tunics, Wellington boots, and the second pair of trousers.

115. This is a good time to check the size roll (para. 26), and to see that the sizes found to really fit the men are duly recorded there. The regular yearly entry of the "sizes" is now made in each man's pocket ledger, in the form for that purpose, and certified by the Major. To insure all the men attending, see para. 72. A list of all absentees, fitted or not fitted, is made and attached to the ledger for after reference. In entering the annual issue in the nominal roll it is unnecessary to detail all the chevrons, numerals, etc., as Pimlico take it for granted that the garments are issued complete.

116. The tailor is paid for the alteration of the clothing at rates as ordered in Army Circulars, clause 2 of 1874; or, briefly, thus:—

Tunics, 8d.; Patrol Jacket, 4d.; Trousers, 3d.

Making up garments in material:

Battery Sergt.-Major:	Tunic, 5s.;	Patrol, 4s. 6d.;	Trousers, 2s.
Sergeant	,, 5s.;	,, 3s. 9d.;	,, 2s.
Rank and File	,, 3s. 6d.;	,, 2s. 9d.;	,, 1s. 5d.

Sewing on chevrons, ½d. each; good conduct badges, ½d.; skill at arms, 1d.; trumpeters' 1½d.; artificers' (gunners), 1d.; guns, crowns, each set, 1½d.; great-coat grenades and numerals, 1d. for each garment, or ¼d. a numeral.

This allowance is claimed on W.O. Form 56 with date of authority (see para. 105), signed as received by the tailor, certified by the Major, and sent to Pimlico for pre-audit. On its return approved, the amount is drawn on the Pay List supported by the form. The allowance ought properly only to be drawn for the garments actually issued to the men, but this is hard to manage, as it is almost impossible to give the P. C. number (authority for supply of the clothing) if the garments now altered have remained long in store. The tailor often requires, and receives, an advance proportioned to the progress of the alterations: this is made by the Major from the battery cash, and is shown as a credit in the monthly balance sheet (para. 14) till recovered by the claim being drawn. The man pays 8d. for wadding the breast of a tunic or jacket, the charge being made in his ledger sheet, and paid in the cash book in a block sum to the tailor at the end of the month. As, however, the clothing is now entirely the property of the state, it is difficult to see why this charge should fall on the man, and it will probably disappear in time.

117. As soon as the mass of the April clothing has been issued, or, if preferred, at the time of its receipt by each man, measures have to be taken to withdraw the corresponding old issues that the new articles replace. The same rule holds good for these as for the October boots (para. 109); the Major can allow them to remain a year longer in possession of the men if they are in a fit state to be of real use; they

should, however, all be called in, examined, those that the men wish to keep given back, and the others entered as received in the clothing stock book (para. 25 B), struck off the men's detailed account (para. 171), and placed in store. The boots will generally be all useless. In April 1880 the men will presumably have to give up their annual ankle-boots issued in April 1879, and their biennial Wellingtons issued in April 1878; as well as any other boots of previous issue not yet taken from them. The October 1879 boots will, of course, remain in their possession. The tunics of April 1878, the patrol jackets and annual trousers of April 1879 have completed their time, but they probably will be of use if left with the men. The biennial trousers issued in April 1878 have completed their time, and will probably be useless. The men have most likely still got in their possession tunics of April 1877, some of which, being P.W. issues, are not their own property, and patrols of April 1878, and some trousers of April 1878; these will probably be given up. It is no good to let men keep articles that have become bundles of rags; but, on the other hand, no consideration as to simplifying accounts, etc., should lead to the withdrawal of articles that may be useful for dirty work, or to depriving a careful man of the advantage he has fairly won by preserving his clothes. This is a point that for several reasons requires the Major's personal attention, as there are great temptations to simplify the ledger by taking into store the whole of a time-expired issue. As to the simplest method of recording the issues and withdrawals of clothing see para. 171. Before these withdrawn garments are placed in store they have to be carefully searched to see that no matches, etc., are left in them, and that they are free from moth and vermin. The receipt of all these articles is duly entered from day to day in the stock book, part-worn portion, but not in the ledger. If the detailed account recommended in para. 171 is used, they are also entered there as taken from the men. As they will all be useless, and be in fact a mass of dirty rags and clouts, which will be kept as short a time as practicable, they are stored separately and according to dates of issue, the annual and biennial issues being kept distinct from one another. They are then got rid of as soon as possible, for which see para. 130, "Surplus." If any are fit for real use, a label is attached to them showing from whom they were taken, etc., and they are dealt with as laid down in para. 152.

118. The prices of all articles of clothing and necessaries are given in the list published, generally annually, in Army Circulars. At present they will be found in the Appendix to clause 133, A. C. of June 1879. For brass numerals, initials, etc., see clause 121 of 1877; helmets, 239 of 1879. The price or value of a part-worn article is found by deducting from its full value a proportionate part for each month of its full term for which it has been worn. The prices for purposes of compensation for clothing not issued will be found in A. C. 2 of 1874, except the patrols, the monthly rate for which is sergeants 2s. 11d., rank and file 1s. 2d.

The price put on articles worn their full time is as follows, but three times that price is to be charged for any such article made away with: the legal question as to how a man sentenced to make good the value

of anything is to be charged three times its declared value remains to be settled. Tunic, 1s.; patrol, 10d.; annual trousers, 1s. 3d.; biennial, do., 11d.; Wellingtons, 9d.; ankle boots, 6d.

Great-coats and Capes.

119. Great-coats and capes are demanded from time to time as required. Usually all the unserviceable coats in the battery are brought before a Board of Survey in the spring and in the autumn, and are condemned. The proceedings of the board are prepared on W.O. Form 130, on the back of which is a size roll and a form on which to demand new coats to replace those condemned. The same form is used when coats are required at any time, although none may be condemned, but only a larger number required. The sizes in the roll are generally too short, and an extra allowance of two sizes should be made in the demand, coats intended for men 5 feet 9 inches suiting men 5 feet 7 inches tall. The coat should be long enough to come down to the man's leggings. The numerals, grenades, and the chevrons on blue cloth required for the new coats are included in the same form, 130. The supply, when received, is treated, as to survey and record, exactly as the April clothing. Before issue from the battery store all the numerals, etc., are sewn on by the tailor, who receives 1d. for each coat, drawn on W.O. Form 56 after pre-audit. Each coat (and its cape) is marked with a certain number, one of a consecutive series, so that all the coats that have ever been issued by a battery are numbered in one regular series. They are also marked with the man's number, battery, and the date of issue. The marking is done with the wooden types used for the clothing; for this 1d. per garment (see A. C. 2 of 1874) is at present allowed to the battery. The charge is recovered on W.O. Form 857, sent to Pimlico for pre-audit, passed and returned from there with W.O. Form special 20, authorizing the payment, and then entered in the Pay List, supported by the two forms as vouchers. After 1 April, 1880, one allowance covers all charges for marking (A. C. 15 of 1880).

120. When a new great-coat is issued, an entry is made in the clothing stock book, in the man's account book, and in the detailed account, both the last entries being signed by the man, and that in his book being certified by the Major. Its issue is also entered against the man's name in the nominal roll, and in the clothing ledger, a "|," if it is a new coat, being inserted in the proper column. Full particulars of the coat are also entered in the register of great-coats (see para. 28), and the date of its issue and the name of the man receiving it are entered there. Once issued, the coat hitherto "new" comes under the heading "part worn," and is accounted for under that heading (see para. 150).

121. A great-coat may be returned into store before it is worn out, as

its wearer may outgrow it, be discharged, desert, etc. Its receipt into store is recorded in the detailed account and in the clothing stock book, P. W. part, and in the register of great-coats, where the cause is also entered (see para. 28). It is still shown in the clothing ledger as part worn, but as "In Store," not "In Wear" (see para. 161). If it is re-issued to another man the date of re-issue is marked on it "Re-iss. 5, 9, '79," below the other marks. (See A. C. 15 of 1880). The issue is recorded in the stock book, and in the register of great-coats, the old number being retained, and the name of the man being entered in the register. In the man's account book, in the detailed account (para. 171), and in the nominal roll of the ledger, the issue is recorded as for a new coat, except that the letters P.W. and the date of original issue are inserted in the proper column, thus: $\frac{\text{P. W.}}{78}$ instead of a "|."

122. On transfer to another garrison battery a man takes his coat and cape, leaving the numerals. The coats so received are not renumbered. Full particulars of the coat, the name of its wearer, the date of his transfer, and from what battery, are entered in the register of great-coats, para. 28. For transfers see para. 141.

123. Recruits sent from other districts unclothed will generally bring with them unserviceable great-coats issued to them at their Brigade Depôt. The officer issuing the coat sends a regular receipt and delivery voucher, W.O. Form 1220, for these coats, the receipt is signed and returned, the delivery voucher is clipped to the ledger, and an entry is made of the receipt of the coat in the clothing ledger, part worn, at page 20, "Condemned Coats." These coats are dealt with under clause 64 A.C. of 1875, that is, they are taken from the men, their receipt into store entered in the part-worn side of the stock book; and authority for their return to Pimlico at once requested. When authority for their return is obtained, they are sent off with regular vouchers, and they, and the case containing them, are struck off the ledger, and off the stock book. They are generally very dirty, and should be carefully cleaned from vermin, and kept separate from all other clothing. Their issue to the men is not entered in the nominal roll, or in the account books, or the detailed account.

124. Both coats and capes ought to be regularly examined at least once a year, say about end of July, when all the marks are compared with the register, and are renewed if faint; no charge is allowed for this, if they have become effaced from fair usage. This examination stops many irregularities that pass unobserved at weekly or muster-day inspections, besides being necessary to keep the register correct.

125. Unserviceable great-coats and capes are condemned by a board of survey, on W.O. Form 130, which form also shows what coats are

required to replace them, and what it is intended to do with the old coats. They should last five years, but special circumstances may be considered (see clause 27 of A.C. 1877, para. 19, and para. 11 of the instructions therewith). As soon as the new coats are ready the condemned coats and capes are taken from the men, their removal being recorded in the detailed account, the grenades, numerals, and chevrons removed from them, and their receipt into store recorded in the clothing stock-book, part-worn part, and in the register of great-coats, where their date of condemnation is also given. On receipt of authority from Pimlico to return them, they are sent off with regular vouchers (W.O. Form 1220), delivery and receipt, the case or barrel being included therein, and they are struck off the clothing stock book and the clothing ledger as issued, in the part-worn part; the receipt voucher, when received back, being attached to the ledger in support. In the register of great-coats an entry is made against each of the coats, so that their end will stand recorded thus: "Condemned by board of survey at Woolwich, 12th August, 1878, returned to Arsenal, Woolwich, 4th September, 1878," one of a batch of 18, under authority, $\frac{\text{P. C.}}{\frac{\text{11 R. A.}}{5370}}$

126. The prices of great-coats will be found in the list published annually or so in the Army Circulars, the last being June 1879. When a great-coat is made away with the value charged for it is its full price less $\frac{1}{60}$ for each month it has been worn. The compensation value is found in A.C. 2 of 1874. On discharge a man leaves his great-coat and cape (see para. 140).

Helmets.

127. Helmets are demanded as required on W.O. Form 306 in duplicate. The size roll is given on the back of the form, and the sizes in A.C. 159, of 1878; but the first time the battery demands helmets each man had best be tried beforehand with several helmets to insure the right size being found: mere measurement is of little use. Pimlico will sometimes, for the first fitting, issue a special set of "helmets, measuring," marked with the sizes for fitting purposes, which are regularly taken on charge and returned in due time; a set of helmets lent by another battery will do as well. A "stretcher" should be included in the first demand; this can alter a helmet a good deal. It is to be remembered that though the helmets are supplied complete, the brass ornaments, the plates, rosettes, spike plates, etc., are all sent down loose, and have to be fitted to the helmets by the battery. The plates give most trouble, as they are issued flat, and have to be bent to the shape of the helmets, in doing which they are easily broken. In fixing the plates, the eyes or eyelet-holes should be rubbed with chalk, and the plate placed on the helmet before any hole is cut for them, till the right place is found: then the plate is pressed against the helmet and removed, and the holes

cut where the chalk-marks are left. Some spare brass ornaments ought to be kept in hand in case of breakage; if Pimlico will not supply them, Haslett or Lyons, of Artillery Place, Woolwich, will do so. No expense to the public is allowed for fitting helmet ornaments, see Artillery Order 98 of 1878. Armourer Sergeants should do this work, see Horse Guards General Order 60 of 1879. The covers for the helmets are demanded, and their receipt and issue recorded in the ledger as separate items.

On receipt, helmets are treated as all other clothing, and are taken on charge in the ledger (page 4) and the stock book as new clothing. Before issue they are marked with the man's number, and that of the battery, as well as the date of issue, the marking being done on the inside of the helmet with a pen and marking ink, and on the outside of the cover with white paint and wooden stamps, the same used for the clothing. The issue to the man of a new helmet is recorded in the stock book, in the man's account book, and in the detailed account (para. 171), the two last entries being certified by the Major. The issue is also recorded in the nominal roll in the clothing ledger by a "|" in the proper column against the man's name. Part-worn helmets taken from men discharged, etc., are treated in the same manner as other P.W. clothing: their receipt into store is recorded in the stock book in the P.W. part, and in the detailed account; and their reissue to another man is recorded in the stock book, in the man's account book, in the detailed account, and in the clothing ledger, under the heading P.W. (page 27) issues to the men, and in the nominal roll. In the roll, the detailed account, and the account book, the letters P.W. and the date of original issue are entered in the proper column, to show that the issue is not that of a new article. When unserviceable the helmets are condemned by a board of survey on W.O. Form 623, in whose proceedings the date of original issue should be recorded. See also para. 7 of Instructions A.C. 27 of 1877. Authority to return them is obtained from Pimlico, the helmets are withdrawn from the men, and recorded in the detailed account as withdrawn, and in the stock book, P.W., as received; packed and dispatched as directed, and they, and the case or barrel containing them, are struck off the ledger, pages 27 and 28, and off the stock book, the ordinary vouchers W.O. Form 1220 passing.

For helmets for warm climates, see clause 27 of 1877, altered by 34 of 1879; for helmets for India, see clause 193 of 1877, and 79 of 1879.

For price of helmets: see A.C. 239 of 1879.

Transfers to and from batteries in England wearing helmets take theirs with them. It should be ascertained before sending the man what head-dress his new battery wears: see also para. 141.

On discharge a man gives up his helmet: see para. 140.

For marking helmets see Royal Artillery Order 94 of 1878, which directs them to be marked in a series as done with great-coats. This plan, however, is not suitable for coats or helmets, or indeed for any articles that are taken away by transfers, as each series involves a separate register. See also A.C. 15 of 1880.

Helmets of transfers are not to be re-marked, see Artillery Order 101 of 1879.

Annual Report.

128. On the 1st April of each year the Major has to report on the clothing of the battery received and worn during the past year; this report is made on W.O. Form 597 through the local commanding officer and general officer of the district: see A.C. 76 of 1878.

Leggings.

129. Leggings are demanded from Pimlico as required on W.O. Form 130 in duplicate. They are made of three sizes, number three the largest, and always remain with the battery, being practically part of the equipment, and being left behind by transfers. They are marked by iron stamps by the battery, with a certain number, one of a consecutive series, the same, if possible, as the sets of arms (para. 185), and are for convenience sake, for battery purposes only, shown in the register of arms, para. 41. They are, however, clothing, and are accounted for in the ledger in the same way as any other article. The register of arms also shows their history. The charge for marking, ½d. each or 1d. per pair, is recovered on W.O. Form 857, sent first to Pimlico for pre-audit, and then entered in the Pay List. After 1 April, 1880, an annual allowance is given for this purpose (A.C. 15 of 1880). They are condemned just like helmets (see para. 127), on W.O. Form 623. For price of leggings see Army Circulars June 1879, appendix, page 25. For leggings see R.W. 2nd January, 1865 (Circular 891), page 84. Their issue to and withdrawal from the men is recorded in the men's pocket ledger, detailed account, stock book, and clothing ledger, just as any other article of clothing. They are given up by men discharged. See para. 140.

Surplus.

130. It will always be a great object to have little clothing in store. It is especially dangerous to keep much new clothing, as it is so valuable. A large stock of good part-worn clothing is very useful, especially to a battery that has to clothe its recruits, but it takes up much room, and batteries now move so suddenly that one cannot calculate on having time to get rid of any large quantity between the date of a shift of quarters being notified and the change being carried out. Thus a battery must always try to keep down its stock. Between the 1st and 7th April of each year the Major is bound, by A.C. 47 of 1879, to send to Pimlico an account of all his surplus new clothing on W.O. Form 883, giving the sizes, taking all his demands as if received, and all his men entitled thereto as if clothed. At all times of the year, however, whenever an amount of new or old clothing is on hand beyond all probable requirements, a Board of Survey should be

held, proceedings on W.O. Form 623, giving the dates of issue of all the P.W. articles, showing annual and biennial issues separately, and recording the state; application should then be made to Pimlico for authority to return them. When authority is granted, the articles are sent with vouchers W.O. Form 1220, which include the cases or barrels sent, and an entry of the transaction is duly made in the ledger, with number and date of authority, at page 11 for the new clothing and the cases, and for P.W. at page 27. All these issues are, of course, recorded in the stock book. For despatch of packages to Pimlico see Army Circulars, clauses 208 of 1878, 89 of 1877, 81 of 1879, 238 of 1879. On all packages sent from the battery, it must be stated by whom they are sent (see A.C. 208 of 1878): the contractors for the carriage of clothing, etc., are, for Great Britain, Messrs. Lavington Brothers, 69, Old Bailey, London, E.C., see A.C. 81 of 1879; for Ireland, Messrs. Chaplin and Horne, Gresham Street, London, see 89 of 1877 altered by 81 of 1879.

Empty cases and barrels can be returned without authority, but the regular vouchers W.O. Form 1220 must pass. Cases can be handed over to Garrison Needlewomen's Association, see A.C. 55 of 1876.

Surplus articles of clothing of any sort are not to be taken to India, see A.C. 197 of 1879, para. 9.

Whether for transfer to another battery, or return to Pimlico, no articles leave the store till surveyed by a board.

Regimental Necessaries.

131. Due provision has to be made for the regimental necessaries required. They are demanded, as wanted, on W. O. Form 307 in duplicate, inspected on arrival by a Board of Survey, as with clothing, and brought on charge in the clothing ledger at pages 57 and 58, and in the necessaries ledger (see para. 24). Their issue is accounted for in the necessaries ledger from day to day. When issued on payment a small calculation is made monthly in the necessaries ledger, across the foot of the columns, to get the value of the articles issued, and to prove that the right amount is recovered from the men and carried to the necessaries fund, or credited to Pimlico at the end of the month. The amounts recovered are credited to Government, monthly or quarterly, in the Pay List, supported by W. O. Forms 611 and 606, and the same amounts are entered in the clothing ledger, page 73, if the necessaries are obtained from Pimlico. The recoveries for necessaries, battery property, are simply carried to the credit of the necessaries fund at the end of the month (see para. 21).

132. When issued to recruits as part of their free kitts, necessaries are accounted for in a separate page of the necessaries ledger. In the clothing ledger they are accounted for at pages 65 and 66 properly, "as per nominal roll," the number of free kitts agreeing with the number of recruits shown as clothed and kitted. It is probably best in your own

copy of the clothing ledger to insert at page 65 a nominal list of the recruits kitted, with the articles in detail.

133. The price of necessaries is generally detailed annually in the Army Circulars; at present they are ruled by the list issued with Army Circulars of 1st June, 1879. For brass numerals, etc., see 121 of 1877; helmets, 239 of 1879. Necessaries of the same quality and price can be obtained from civilian dealers with the great advantage that final settlement of the account can be made monthly or at any time, avoiding the long delay of one or two years that is inevitable if the goods are obtained from Pimlico. Necessaries for free kitts for recruits, etc., must, however, be obtained from Pimlico.

A battery proceeding to India may take a twelvemonth's supply from Pimlico with it; for details, see clause 25 of 1875, and appendix as altered by clause 8 of 1876, and para. 10 of 197 of 1879. As to supply of necessaries see clause 25 of 1876. For price and supply of Bibles and Prayer Books, see clause 157 of 1876, articles 27 to 29. They are drawn on W.O. Form 681, on 1st January, from the War Office.

134. Necessaries are marked in the battery store, before issue, with the man's number and battery, and, if there is room, with his name. Types or tools for doing this are supplied by Pimlico. The cost of marking the first free issue to a recruit, 1s. 1d., is recovered on W. O. Form 857: for all other issues a charge of ½d. per article is made, recovered in the ledger sheet from the man, and the recoveries paid in a block sum at the end of the month to the marker. A. C. 15 of 1880.

135. Regimental necessaries obtained from Pimlico are accounted for as follows:—The receipts are shown at pages 57, 59, and 64 in the ledger, the P. C. number and date being given in each case, and the issues are entered at pages 65 to 72. The printed items require little explanation. In the battery copy, at least, a nominal roll of the recruits to whom free kitts have been given may be inserted at page 65 to prevent any errors, though the reference to the nominal roll means that every recruit shown there as clothed is supposed also to have been kitted. The item at page 65, "*gratis to transfers,*" only refers to men transferred from other corps whose kitts are completed with articles issued to an artillery recruit, but not worn by the corps they have left. The item at pages 65 and 74, "*to men released from prison,*" does not refer to the ordinary issues on payment to men who have made away with their kitts, but to the issues to replace articles left and sold when they deserted. Para. 100 of Clothing Warrant 1865. Great care will be necessary with the table given at page 73 of articles issued on payment, to see that it is in agreement with the amounts credited quarterly. The final remain given at page 59 must, of course, agree with the remain in the necessaries ledger (para. 24); in fact the necessaries ledger will, to a certain extent, act as a check on this account in the clothing ledger. At the end of the clothing year, the 30th June, the final remain is struck, and all the articles in store are actually counted by the same Board of Survey (see para. 169) that counts all the

clothing, and the proceedings are recorded on W.O. Form 623. It is, however, well, if there is any considerable stock on hand, to count the necessaries at least quarterly, still better monthly, whether they are supplied from Pimlico or not.

Sea Kitt Necessaries.

136. Sea kitt necessaries are demanded as required on W.O. Form 317 in duplicate, surveyed on arrival, and brought on charge at page 79 of the clothing ledger. For their issue a service battery would alter a special page of the necessaries ledger (para. 24). The prices of these necessaries are given from year to year in Army Circulars, with those of regimental necessaries; at present they are ruled by the list issued with Army Circulars of 1st June, 1879. The account in the ledger requires no explanation. At the end of the year the remain is counted by the same Board of Survey that counts all the clothing (para. 169), and it is included in their proceedings on W.O. Form 623.

Sea kitts should only be given to the men at the last moment before embarkation (see Horse Guards General Order 61 of 1878, para. 2). On disembarking, men may retain these kitts, if General Officers give authority (see Horse Guards General Order 104 of 1879).

Recruits.

137. A service battery often has to clothe its own recruits, a bad plan, as a battery can seldom have a sufficient stock of new and of part-worn clothing. By Army Clothing Department letter of 8th March, 1879, $\frac{\text{P. C.}}{\frac{\text{No. a, R.H.A.}}{512}}$, which is only circulated in manuscript, the rules are:

Recruits enlisted between 1st April, 1879, and 31st December, 1879, are to receive a new tunic to last to 31st March, 1881.
Or a P.W. tunic of 1879 issue to last to 31st March, 1881.
Or „ „ 1878 „ „ „ 1880.
And 1 new patrol jacket and 2 pairs of trousers.

If enlisted between 1st January, 1880, and 31st March, 1880:
A new tunic to last to 31st March, 1882.
Or a P.W. tunic of 1879 issue to last to 31st March, 1881.
Or a „ „ 1878 „ „ „ 1880.
And 1 new patrol jacket and 2 pairs of new trousers.

All recruits may also be given additional issues of P.W. garments under paragraph C of the letter above quoted. All the P.W. articles are to be equal to those in wear by the rest of the battery.

138. Practically the treatment of a recruit is as follows: As soon as he is posted application is made to the head quarters of the brigade for a brigade number to be allotted him. He is immediately fitted with a P.W. suit, to be worn on all fatigues and at recruit drill. The battery will generally have been able to get his regimental necessaries beforehand, and these are marked and issued at once. Probably no clothing of his

size may be in store, and some is borrowed, if practicable, while a demand is sent in, garments W.O. Form 81 in duplicate, 1314 in triplicate, boots 305 in duplicate. Its issue is shown in the ledger, small account book, detailed account, and stock book, as for duty men, except that in the ledger a separate list of recruits is made at the end of the nominal roll. It is well to have two witnesses besides the Pay-Sergeant, who all sign the entry of the issue of the clothing in the stock book or in the detailed account, and that of the necessaries in the necessaries ledger, so that when the recruit is tried for fraudulent enlistment it may not be necessary to send the Pay-Sergeant away, as the sole witness, to the place at which the court is held. Some care should be taken with these entries, as it will be seen that the collusion of one or two persons would make it easy to record issues against recruits who deserted really unkitted or unclothed.

139. The issue of a tunic to recruits, especially when they are young lads, about to go through a gymnastic course, should be delayed as long as the local authorities permit. The tunic ought not to be fitted, if the regulations only allowed it, till the man has been six months in the service. Great care has to be taken that recruits do not wear their good clothing on fatigue.

The cost of marking a recruit's regimental necessaries, 1s. 1d., is recovered on W. O. Form 857, sent to Pimlico for pre-audit, and then inserted in the Pay List, supported by the form.

The supply of a Bible and a Prayer Book to a recruit is made by the battery, who obtain them from the War Office as prescribed in clause 157 of 1876, articles 27 to 29, that is by annual requisition on W.O. Form 681, on 1st January.

The helmet, great-coat and cape, and leggings issued to a recruit will generally all be part-worn. Such issues are treated as any other part-worn issues, that is, recorded, not by inserting a "|" in the proper column in the various books, but by putting in the letters P.W., with the original date of issue of the article below. The date of its re-issue to the recruit is marked on the coat, see A.C. 15 of 1880.

Discharged Men.

140. The case of men discharged time-expired or at their own request, by purchase, or invalided, etc., or transferred to Army Reserve, is governed by paragraphs 4, 22, 23, 24, and 25 of Letter $\frac{\text{P. C.}}{\text{General No. 2911}}$ of 1st February, 1879. Such men retain all their necessaries, but give up every article of clothing, however old, except one pair of ankle boots. They receive on the day they leave a suit of plain clothes: that is, a cap, neckerchief, jacket, waistcoat, and a pair of trousers. This suit (not articles) is demanded from Pimlico about a month before the date of discharge, on W.O. Form 310 in duplicate, size roll thereon, and is received with the usual vouchers, and taken on charge in the ledger and stock book (new part) just as any other articles, but

as one suit. The regimental clothing in the man's possession ought to be examined some time before he leaves, to make certain that he has all his articles, and that they are in a fair state of repair, according to their date. On the day of his discharge all his clothing, however old, is taken from him, great-coat and all, except one pair of ankle-boots. The articles thus taken are entered in his detailed account as withdrawn, with a note, "see page — stock"; and in the stock book they are shown as P.W. receipts. The suit of plain clothes is entered in the detailed account (as one suit) as issued to and taken away by the man who signs for receiving them. They are shown in the ledger (nominal roll and page 12) as issues. These suits may be provided by the battery (see paragraph 23 of above-quoted letter) for 12s. Such suits are accounted for as those received from Pimlico, the allowance being drawn quarterly on W.O. Form 279.

If the men prefer they can draw an allowance instead: Battery Staff and Sergeants 20s.; other ranks 12s. This allowance is drawn at once on W.O. Form 279, sent for pre-audit to Pimlico; the sum paid to the man is entered in his battery ledger sheet, as well as the battery cash account; and a note that he has received it is made in his detailed account, or even a formal receipt for it is entered therein. Settlements with discharged men cannot be too well vouched for, or in too many places. This allowance is only paid to the man when he has provided and appears in the clothes for final settlement; otherwise he may place his Major in a disagreable dilemma if he makes away with them. Suits provided by the men themselves are not accounted for at all by the battery. In the winter season, if the weather is severe, special application should be made to Pimlico for the issue of jerseys or great-coats to discharged men, particularly if they have to travel far by steamer. The case of men discharged with ignominy, or for fraudulent enlistment, is fully described in Army Circulars, clause 80 of 1879 and 139 of 1877.

The ankle-boots taken away are so shown in the nominal roll and in the detailed account.

Transfers.

141. On transfer from his battery a man takes all his necessaries, and, except his leggings and numerals, all his clothing of use to him in his new corps. A transfer from a garrison battery to a garrison, or to a field battery, takes all his clothing. It should be first ascertained what head-dress the new battery has, so as to withdraw the man's helmet, or busby, if not worn by them. A transfer to the Horse Artillery leaves his head-dress, great-coat, cape, tunic, and patrol jacket. If transferred to the Infantry, he leaves all clothing, except his ankle-boots. A transfer from the Horse Artillery to Garrison Artillery, leaves his head-dress, jackets, pantaloons, knee-boots, spurs, gloves, and cloak. From a field to a garrison battery he takes everything, if he has a dismounted kitt; if he has a mounted kitt, he leaves his cloak, pantaloons, knee-boots, spurs, and gloves. To Army Hospital Corps

he gives up all clothing, except his boots, and one suit to travel in, and takes a worn-out coat, his clothing being kept in store till he is finally accepted or rejected, see A.C. 112 of 1876. To Militia Permanent Staff, he takes all his clothing, see A.C. 7 of 1876.

To Army Reserve he leaves all, and does not get any new issues if transferred in the first or June quarter, see A.C. 154 of 1876. From Army Reserve, see A.C. 105 of 1878. From Militia Reserve, see A.C. 104 of 1877, and 105 of 1878. From Militia, see A.C. 178 of 1877.

All transfers have their necessaries completed, free of expense, to the establishment of their new corps. For the issue of these articles see Artillery Order 93 of 1878, page 18: for expense of marking them see 98 of 1878, page 13. Necessaries already in possession of transfers are not re-marked, see same Order 98 of 1878, nor is clothing, see A.C. 15 of 1880.

For transfers from or to batteries in warm and cold climates, see A.C. 27 of 1877; altered by 34 of 1879.

For Invalids and transfers from foreign stations (helmets), see A.C. 34 of 1879, para. 2.

For transfers from England to India (helmets), see A.C. 193 of 1877, and 79 of 1879.

For transfers from foreign stations to India (helmets), see A.C. 193 of 1877, para. 4.

For transfers from India (helmets), see A.C.

Transfers to or from any foreign stations except India, A.C. 34 of 1879 (helmets). White clothing, A.C. 27 of 1877, as altered by A.C. 34 of 1879, clothing.

For transfers see also Artillery Order 57 of 25th November, 1873, altered by 76 of 1876.

142. All the clothing, however old, taken away or brought by a transfer, passes from the charge of his old battery to that of his new corps. A clothing transfer return, W.O. Form 32, therefore accompanies each transfer: this return contains a full statement of all the clothing the man has in his possession when he leaves his battery, with the date to which each article is to last, and the amount of compensation he is entitled to for any article not issued. Special notes should be made against any time-expired articles left in the man's possession, to show what they really are, and to distinguish them from the regular issues not yet worn their full time. If any article has been taken from the man by his old battery, as not worn by his new corps, it is still entered with a note in its proper column, to show that it has been issued and withdrawn, and so to prevent any claim for non-issue; in such cases care must also be taken that the receipt into store of such withdrawn articles is noted in the stock book and in the man's detailed account (para. 171). When a man is transferred after conviction for making away with clothing which has not been replaced, full details of the original issue, of its loss, and of the amount to be recovered, should be given. It is obviously very important to both the corps concerned that this return be correct, and each has to ascertain by actual inspection that the articles corre-

sponding, not only in number but also in date of issue, with the return are actually with the man, and that the return, the nominal roll, the detailed account, and the man's account book all agree in both batteries. The return itself is prepared in duplicate, compared as above, signed by the man; one copy sent with his papers, the other attached to the ledger, after being carefully copied into the book kept for that purpose (para. 27). In the nominal roll of the battery he leaves, all the articles shown in the transfer return are carefully entered by date of issue in the columns headed "Taken by Transfers," so that they may be struck off the charge of the battery. The man's "detailed account" will have been closed beforehand, and a note is made therein to show to what corps he has gone. The battery that receives the man carefully compares this transfer return with the articles brought, and with the man's account book, copies the transfer clothing return into their book for "Transfers Received," enters the man's name in the nominal roll of their ledger (para. 164), and inserts all the articles shown in the return opposite the name, by date of issue, in the column headed "*Received with Transfers*"; then the return is attached to the ledger to eventually be sent with it to Pimlico. A sheet is then opened for the man in their detailed account, and all the articles brought on there, with a note to show the battery from which received, the date of issue of each article being given. For example, a man that brings on transfer two jackets would, both in the nominal roll and his detailed account, have the original date of issue, say "78" and "79," of the jackets entered in the proper column, not simply the total "2."

Transfer clothing returns for men going to India are sent direct to the depot or other battery, see Artillery Order 76 of 1876, page 18.

Clothing Chest.

143. A chest to store the surplus clothing in can be demanded on manuscript form, from Pimlico. It is brought on charge in the clothing ledger, and so carried on from year to year.

Clothing.—Compensation.

144. Compensation to men for clothing not issued is granted under the conditions stated in letter $\frac{\text{P. C.}}{\text{General No } 2911}$ $\frac{\text{P. C.}}{\text{19th Hussars } 474}$ of August 1879, and in paras. 8 to 12 and 15 and 16 of letter $\frac{\text{P. C.}}{\text{General No. } 2911}$ of 1st February, 1879; these regulations appear to be as follows:—

Sergeants and Staff-Sergeants promoted to that rank, on and after 1st October, retain their clothing till 1st April, when it is replaced by new articles for their proper rank. They then return their old clothing, and receive the difference in value of the clothing from date of pro-

motion to 31st March. They are, however, entitled to receive in kind the extra badges and chevrons.

Men coming home from India receive the rates due to them, after authority has been received from Pimlico.

At Hong Kong, the Straits Settlements, and Ceylon, Generals may withhold the issue of cloth tunics and trousers, when compensation will be allowed on 31st March to assist in providing white clothing. See A.C. 34 of 1879, para. 4.

In all other cases compensation is only granted to men if all clothing is withheld from them, the Major satisfying himself on 31st March, 1879, that the clothing in their possession will last till 31st March, 1880, and so on, and obtaining the written sanction of the District General to the articles due being withheld. The only exception to this is that boots may, if necessary, be issued when other articles are withheld. Thus a man cannot draw his trousers and get compensation for his tunic. The amount due will be drawn at the end of the year on W.O. Form 604, with a certificate thereon that no issue of clothing in kind has been made, except boots, accompanied by the original authority of the General for withholding the issue.

All compensation is drawn on W.O. Form 604, sent in original, a copy being being kept with the battery, at the end of the year, 31st March, except apparently for men returning from India, for whom it is drawn at once. In the nominal roll of the ledger and the man's account book the letters "C," in red ink, are inserted in each column that the issue, if made, of any article would have been recorded. The same is done in the detailed account, where a note of the amount paid is also given.

For compensation instead of the issue of plain clothes on discharge, see para. 140 of these notes.

Clothing.—Responsibility.

145. It is well, before proceeding to the manner of accounting for the clothing, to consider the Major's liability in reference to it. From the time the clothing enters his store until it is regularly issued to some man, transferred to another battery, or returned to Pimlico, the Major is responsible for any loss or damage to it. If any deficiency or injury is believed to have occurred between the time the clothing left Pimlico and its examination by the Board of Survey, Pimlico would have to bear the loss or prove the damage was done in the battery store, the Major only having to show that due care was taken of the cases after arrival. Once, however, the articles are taken on charge, that is, immediately the Board of Survey have completed their work, the responsibility for all damage or loss rests with the Major; and, failing proof to exculpate him, he has to make it good. He can only escape the consequent charge by obtaining a Court of Inquiry, and producing evidence before it that he has taken every possible precaution against thieves, fire, damp, moths, and vermin, or whatever may have been the cause of the

particular loss or injury. For example, he must prove that the store was properly attended by day; that no unauthorized person was allowed to enter it alone; that it was properly closed and guarded by night; that no matches, oil rags, or inflammable articles have been left in it; that the gold lace has been kept in a tin box and frequently exposed to light; that, if a barrack room is above the store, care has been taken to prevent the men swamping the floor above with water that may run through; that the cloth garments have been kept with camphor and pepper, and in boxes secure from mice or rats, and occasionally exposed and cleaned; that the boots have been looked after (see A.C. 66 of 1875, article 2, and 207 of 1878); and that all old clothing has been carefully searched for matches and vermin before being placed in store, etc., etc. If the Court report in his favour, recommending that the expense be borne by the public, and if their report is approved, then the Major may escape the charge. It is a new pecuniary responsibility thrown on him since the amount of his contingent allowance was settled, without any addition being made to the allowance, and often without the provision of a proper store.

Once, however, the clothing is issued to the men, the Major is exempt from all direct pecuniary responsibility. If a man destroys or loses his tunic the day after its issue, the man makes good the value, or if the charge cannot be recovered from the man on account of his desertion, imprisonment, etc., the loss falls on the public, as the Major has only to credit the amount actually recovered. The declaration of the Court of Inquiry on a deserter's deficiency of clothing, W.O. Form 875, or the extract of the Court Martial on a man deficient of clothing, or his crime if his trial is dispensed with, are all sufficient vouchers for striking clothing off charge. Indirectly, the Major is still pecuniarily responsible for the clothing after issue, as long as it is actually in possession of the men, as he has to see that it is kept up in proper order; and he is practically responsible for any debts of the men so incurred. Thus it is important for the Major to see that the clothing is kept up in proper state —no easy matter when he has men employed with orders not to go to any parade during the year.

Necessaries are nominally considered in the same manner, but there is an important practical difference. For example, a recruit gets a free kitt, deserts with it, and is no more heard of. Here the extract from the Court of Inquiry clears the Major completely. If, however, such a man rejoins, is tried, and, after his imprisonment, again serves, he must be again clothed and kitted; and, if he again deserts with everything, the second issue of clothing is written off, but the issue of necessaries has to be paid for, nominally out of his estate, but practically, as he has nothing, by the Major. Even if such a man is eventually caught, and has to serve, the debt is so large that its final recovery is very doubtful. If he is discharged the debt is of course all lost. The recovery of the value of a free kitt obtained by fraudulent enlistment, is, however, carried out by a regular stoppage from his pay, only the amount recovered being credited.

Clothing.—Account.

146. The Major has to account for all the mass of clothing received, and to prove all his transactions with the men and with Pimlico. With the men he accounts by means of the form for the clothing account in their own account books. This form shows all the issues to the men, and as both the men and the Major have signed to all entries, and as each issue can be further proved by the man's signature to a corresponding entry in the clothing stock book, or in the case of transfers, by reference to the transfer clothing return (paras. 27 and 142), also signed by the man, there ought to be no dispute about entries. Thus the man has in his possession a complete account of the issues recorded against him, while the Major has in his stock book a detailed account of each issue, and in the "nominal roll" of his clothing ledger (see para. 167) a complete record of all the clothing in possession of the man. However, a great change is required in this system. In the first place, in the man's book the signatures to each issue are on a different sheet to the record itself, so that by accident or design all the signatures can be separated from the account and destroyed. In the next place, the form gives the man no record of the withdrawal of old articles taken away as time-expired. Now there will in future be a constant series of such withdrawals, and provision should be made to record them in the man's book. It appears to me that these withdrawals of old issues, and the difficulty that will exist, with the best-kept accounts, as to the exact number and dates of issue of articles of clothing the man has in his possession, will make it necessary to start an entirely new account with the men. I propose a "Clothing Detailed Account Book," for which see para. 171.

147. With Pimlico the Major accounts as follows:—The clothing is divided into "new," that is, articles never issued to any man, and "part worn," that is, articles that have been issued; and the system of account is that a new article received by the battery is taken up and accounted for as "new" until it is issued, when it is struck off the "new" account and taken up as "part worn." Under this latter heading it is accounted for as long as it is in wear or in store, until it is regularly struck off the charge of the battery. Thus all clothing taken away by a transfer is obviously P.W., and is so struck off that heading. Clothing brought by a transfer is also P.W., and is so taken up under that description. This rule, as do all the details in the following description, applies to all articles of clothing, tunics, boots, helmets, coats, leggings, etc., but not to necessaries, the account of which ceases with their issue.

148. All the account with Pimlico is contained in the clothing ledger which records every transaction for one year from 1st April, under the following heads: New Clothing; Part Worn; Nominal Roll, or detailed account of the issue to each man; Regimental Necessaries; Sea Kitt Necessaries.

New Clothing.

149. The first item at pages 3 to 10 will be the "Remain" at the end of the last year, 30th June, 1879, taken from the last year's ledger, as proved by the Board of Survey then held on it; this remain will of course agree with that shown in the stock book (para. 170), "new" part. Then come the receipts of all new clothing, uniform and plain clothes (see para. 140), and of cases and barrels, canvas, etc., at pages 3 to 10. Each entry of a receipt gives date of requisition, the date of Pimlico's letters in reply to demand, announcing supply will be made (see para. 105), that is, the P.C. number, and its correctness is proved by the delivery vouchers, W.O. Form 505, received with each lot, and clipped to the ledger. Against the total of these receipts will, at the end of the year, come the total of "issues" from pages 11 to 18, mainly, of course, the issues of annual and biennial clothing for October and April to the men, and of the new clothing supplied to recruits, and of suits of plain clothes issued to discharged men (para. 140). When struck, at the end of the year, the total of the issues at page 5, etc., must agree with the total shown in the nominal roll, as issued to the men, of new clothing (see para. 163), remembering always that the articles thus struck off as issued do not pass out of the battery's charge, but are again brought on at page 19 of the ledger as part-worn. There may also be some issues on repayment "sold," which will be shown in detail at page 53 of the ledger, where, in the battery copy, it is as well to insert, in red ink, the names of the men buying the articles, and the monthly amounts recovered and credited. Note that all the articles "sold" will eventually have to be given up by the men; they may not sell or make away with them. Some of the clothing may have been returned to Pimlico, or transferred to another battery as surplus, under due authority. Some, at least, of the cases, barrels, canvas wrappers, etc., will also have been returned, or sent off with some clothing to another battery. Each transaction will stand recorded at the time, duly supported by receipt vouchers. For handing over cases to Garrison Needlewomen's Association see clause 55, A.C. of 1876. The "Remain" at pages 5 to 10 should be struck by 31st March, and must agree with the remain of new clothing shown in the stock book. On the 31st March all the articles are counted by a Board of Survey, whose proceedings on W.O. Form 623 are attached to the ledger: see also para. 169.

Part Worn.

150. The account of the "new" clothing is comparatively simple, that of "part worn" is more complicated. Once a new article of clothing has been regularly issued to and worn by any man, it comes under another heading, and is described and accounted for separately as "part worn." All clothing issued on and after 1st April, 1878, and new clothing issued to recruits on and after 1st January, 1878, never becomes the property of the soldier, but remains always on charge as P.W., whether it be actually in wear, or taken back into the battery

store, until it is formally struck off, either by being returned to Pimlico, transferred to another battery with its wearer, taken away by a deserter, made away with, or lost. Each such entry has to be proved by some voucher; thus, a return to Pimlico is supported by a receipt voucher from the Department (W.O. Form 1220). A transfer with a man is proved by the transfer clothing return, W.O. Form 32; while a loss by desertion, etc., could, if required, be proved by the extract from the Court of Inquiry if the man never returned, or an extract from his Court Martial or "crime" if he rejoined.

151. The battery receives P.W. clothing in three different ways; firstly, from the "new clothing" issued to the men. For example, all the new boots issued in October are at once struck off the "new" account and brought on as "part worn." Secondly, with men transferred, as all the clothing a man has in his possession at time of transfer, as shown by his clothing transfer return, W.O. Form 32, is struck off charge by the battery that he leaves, and is taken up on the P.W. account of the battery he joins. Thirdly, it may demand and receive P.W. clothing for issue to recruits (para. 137), or to men about to be discharged. All these receipts are actual additions to the battery P.W. stock, and are shown as receipts, both in the stock book and in the clothing ledger in the P.W. part. The battery issues P.W. clothing to recruits or to men about to be discharged, but these issues do not diminish the amount on its charge, as they remain just as much on charge while worn; and are simply struck off on one side of the account as issued, to be brought on the other as received from issues. The amount of P.W. in charge is diminished by the articles taken away by transfers, and by the articles returned to Pimlico, or transferred to other batteries, whether condemned or not, and by any articles in wear being lost or made away with.

152. The stock of P.W. clothing, not in wear but kept in the battery store, and shown as on hand in the stock book, is received into store from different sources. All clothing of men that have died, that have been discharged, or that have deserted, is taken into store, as well as any articles left behind by transfers (para. 141), as not worn in their new corps. Corporals promoted to be sergeants, sergeants promoted to be sergeant-majors give back their tunics, patrol jackets, trousers, and chevrons (except they are promoted on or after the 1st October, when they retain their old clothing until the 1st April, when they give it up), and receive compensation, drawn after 1st April on W.O. Form 604, after pre-audit. For these promotions see paras. 14, 15, and 16 of Letter P. C. General No. 2911 Many of these articles will be in a good state, and will be very useful as issues to recruits (para. 137), or to men about to be discharged (para. 101). The receipt of all these articles is duly entered from day to day in the stock book, but not in the ledger. It is a good plan, when possible, to attach to each P.W. article thus received a label showing

from whom it was received. For the disposal of these articles see para. 130, "Surplus."

153. Besides these useful additions to the stock in store, a mass of P.W. clothing is received into store each year in April and October, as the previous issues that have worn their full time are then for the most part withdrawn: see paras. 109 and 117. As the serviceable articles will generally be left with the men, the store thus receives only a lot of useless and dirty rags and clouts, which it tries to get rid of at once. See "Surplus," para. 130.

154. Note that the receipts mentioned in the last two paragraphs are only receipts by the store, not by the battery, as their return into store by the men does not affect the battery account with Pimlico, except that at the end of the clothing year they would, if still in store, be shown as "in store," not "in wear," at pages 21 to 26 of the ledger: whether in store or in wear, they are equally in the Major's charge. It is only P.W. clothing taken up from issues of new clothing, or received from outside the battery, that are acknowledged as receipts in the ledger; the other receipts are mere battery transactions, and are only recorded in the stock book. Thus, if a man returns into store an old tunic, there is no difference in the number of tunics shown in the ledger as in charge; there will only be one more in store, one less in wear. The stock book, however, will show one more tunic in its account.

155. The P.W. clothing is accounted for at pages 19 to 34. The first entry, the "Remain," is made up of two items brought forward from the last year's ledger; *firstly*, the P.W. clothing shown as "in wear" at page 21 of the old ledger, the grand total of all the articles all the men had in their possession on 30th June, 1879, no matter how old or how new; *secondly*, the P.W. clothing in store at the end of the last year, 30th June, 1879, as shown at page 21 of the old ledger, agreeing, of course, with the "remain" in the stock book on the same date. The first item, "in wear," can, if necessary, be proved in detail, for it is the total of all the black and red ink entries in the nominal roll of the old ledger (see para. 167), less the new issues taken away by transfers. When the detailed account book (see para. 171) is kept by a battery, this item can obviously be easily checked, as it is the total of all the articles shown there as in each man's possession on 30th June, 1879. It is well to give this explanation here, as on a change of the battery staff, questions may be raised as to the correctness of the old ledger, if the new ledger shows a wrong balance. The second item, "in store," ought to be above question, as a Board of Survey should have verified it: see para. 169.

156. Next comes "From New Clothing," that is, all the new articles shown as issued in the "nominal roll" (see para. 163) and in the account of new clothing as issued to the men during the year, all these issues being struck off the new account and taken up as P.W. This total is carried back from page 52 to 19.

157. Next comes "From P.W. Clothing" (inserted in manuscript), that is, all the P.W. articles shown as issued in the nominal roll (para. 163) to the men during the year. This is a mere entry of account to balance the same entry shown later (para. 160) on the other side. Some batteries do not show the issue of P.W. articles in the nominal roll, and they, of course, neither take them up here, nor strike them off on the other side; but in the prevailing uncertainty, it seems to be better to adhere to a system which records all transactions.

158. Next comes the total "*received with transfers*" carried back from page 52, and being the total of the transfer clothing returns as carried into the columns with that heading, "received with transfers," in the nominal roll (para. 164). The words in the heading "*and given up by casualties*" are now obsolete, and refer to the old regulations.

159. Lastly comes all other receipts, from Pimlico, from other batteries, etc. (see para. 151), each item supported by a delivery voucher, W.O. Form 1220, attached to the ledger.
The total of all these receipts is carried to page 21.

160. The issues are shown at page 27, and need not be described in detail. The item "*issues to the men*" will not be used by batteries that do not show such issues in the nominal roll. The words in the second printed item "*and become the property of the men*" will cease to be used shortly, and do not apply to any article issued in or after April 1878, in Great Britain and Ireland, as they are always public property.

161. The total issues, struck at the foot of page 29, etc., is on 31st March carried back to the foot of page 21, and then deducted from the receipts; the "remain" being composed of two items (see para. 155), the P.W. articles in wear on 31st March, checked by the nominal roll (para. 167), and by the detailed account (para. 171), if necessary, and the P.W. articles in store, checked by the stock book, and actually counted by a Board of Survey on 31st March, 1880.

Nominal Roll.

162. The nominal roll at pages 35 to 51 is the part of the ledger that requires the most care. It is opened so as to be ready by the 1st April, by entering the names of every man in the battery, in alphabetical order by ranks, as they stood on 30th June in the last ledger, except that the transfers and recruits that joined during the last clothing year, and that were then shown separately, are now inserted in their proper places alphabetically. At least one blank line is left between each name to give space for the red-ink entries of P.W. clothing in possession, described later (para. 167). Men joining during

the year have their names placed at the end of the others, but before recruits.

Recruits are entered in a separate list with that heading. Non-commissioned Officers promoted are shown first in the rank they held on 1st July, and then in that to which they were raised; thus a corporal promoted sergeant in November 1879 would appear among the corporals, where his October issue of boots would be recorded, and then among the sergeants for his April issue.

163. During the year, as each issue of any new clothing is made to a man, a "|" in black ink is inserted in the proper column against his name. If any P.W. issue is made, whether tunic, helmet, etc., instead of a "|" the letters P.W., with the original date of issue of the article below, are inserted in the proper column; thus, a man receiving in July 1879 a tunic of 1878 issue, would have $\frac{\text{P.W.}}{78.}$ inserted in the "tunic" column opposite his name. These entries must be carefully checked, both at the time of issue and in October and April, after the two yearly issues, by means of the stock book, the detailed account (para. 171), and the men's account books. The man's signature to the stock book, or the detailed account, and his own book, will prove the issue; whether he was really entitled thereto can be proved by reference to the old ledger if he was clothed last year by the battery, or if he was a transfer by reference to the transfer clothing return book (para. 142). The detailed account, however, is the best for reference, as it gives such a complete history of the issues. When compensation is given the letter "C," in red ink, is entered in all the columns in which the issue of articles would otherwise have been recorded.

164. On receipt of a transfer his name is entered after the others, before recruits, and all the articles brought with him are inserted opposite his name in the columns headed "Received with Transfers," great care being taken to insure these entries being in exact agreement with his transfer clothing return, and that he really has all the articles, not merely the same number but the real articles as shown by the dates of issue. If he afterwards receives any article from the battery, an entry is made in the same column as for the other men. When a man is transferred from the battery, a full entry of all the articles taken by him is made opposite his name in the column "Taken away by Transfers": this entry must exactly agree with his transfer clothing return. If the transfer return shows any article as taken from the man, because it is not worn by his new corps, it is not entered in the ledger, but care is taken that its receipt into store is recorded in the stock book and in the detailed account.

165. At the end of the year, so as to be ready by the 31st March, the entries in all the columns of the nominal roll are added up. At the foot of each issue column are two totals, the one of the "new" issues, the other of the P.W. issues; these totals, carried through to page 52, must of course agree with the total of new issues shown at page 11,

and of part worn, at page 27. The total of the columns "Received with Transfers" is carried to page 52, and that of the columns "Taken away by Transfers" to page 52. The final balance can now be struck of the "New" and "Part worn" accounts, and the "remain" in both ascertained. A Board of Survey is assembled on 31st March, and the "remain" actually counted; the proceedings are made out on W.O. Form 623, and attached to the ledger.

166. Some batteries, it appears, do not enter the issue of P.W. articles to the men, unless they remain in the men's possession at the end of the year, when they appear in red ink (see next paragraph); other batteries duly enter such issues, but do not carry out their totals to page 52. The course proposed in these notes seems more exact.

167. All the other work of the ledger being completed, entries in red ink are made opposite the name of each man who is present with the battery on 31st March, to show what articles, issued in former years, are in his possession. This is done by inserting in red ink, in the proper column, the date of original issue of the article. These red-ink entries are not included in the totals, at the bottoms of the pages, but are counted in the total shown at page 21 as "In wear." Here will be found the use of the "Detailed Account," suggested in paragraph 171, as without it, it will be most difficult to ascertain what each man really has. If no articles were taken from a man the work would be comparatively easy. For example, Gunner Shepherd receives on 1st October, 1879, a pair of ankle-boots, and on 1st April, 1880, a jacket, a pair of trousers, and a pair of ankle-boots; all these issues are represented by a black "|" in the four proper columns. He had previously, in 1878, received a tunic, a jacket, a pair of biennial trousers, a pair of annual trousers, and a pair of Wellingtons, all new; the figures "78" in red ink are therefore entered in the proper columns against his name, on the line left blank, if practicable, so that in the column "Jackets" a red-ink "78," representing the old jacket of that year in his possession, comes below the black "|" representing the new jacket he has just received. He had also, in 1878, received a part-worn great-coat, cape, helmet, and leggings, all originally issued in 1877, a red "77" will therefore appear in the proper columns. In such a case the nominal roll gives at a glance a complete inventory of the clothing in a man's possession at the end of the year. Now, however, that the account becomes very complicated by withdrawals of clothing, some change is required. I propose to alter the ledger by printing a special page, or pages, for "Transfers Received," and utilizing the columns now so headed as a record of what each man has returned into store. Until this is done it will only be by a "Detailed Account" (para. 171) that the clothing in possession can be really checked. Note that if any of the articles issued to G. Shepherd, as above, had been returned into store as worn the full time, the "78" jacket for example, it would have simply disappeared from the nominal roll without remark, and its fate could only be traced in a battery

keeping a stock book or a detailed account. The fact of any article being made away with and not replaced would be still more difficult to trace in after years.

Articles made away with.

168. A man who makes away with any necessaries, except for those of a free kit fraudulently received, is only placed under stoppage to replace them; this is simply a battery transaction, as the Major has to supply him, and if the articles are not replaced—for example, if the man is discharged after trial—no stoppages are made. In the case of a free kit fraudulently obtained, the man has to pay the full original value of the necessaries, the money being credited as recovered, no payment being made by the battery till recovery. For any article of clothing made away with, the man has to pay, not the cost of replacing, but the unexpired value of the article made away with. The price of clothing and necessaries is at present given in A.C. 71 of 1880, Appendix, except helmets, for which see A.C. 239 of 1879, and brass numerals, etc., 121 of 1877. Thus for clothing a man is charged the full value less the proportionate part for each full month the clothing has been worn, but plus the value when worn out. Only the amount actually recovered is credited monthly in the pay list, and these amounts are recorded in the form given at page 53 of the clothing ledger. As soon as a man is convicted of losing or making away with any article, a note to that effect should be made in the nominal roll against the man's name, and also among the issues of part worn, page 27. The articles taken away by a deserter are written off in the nominal roll under the heading "Taken away by Transfers and Deserters." In the detailed account (para. 171) all articles of clothing lost or made away with are at once entered with full remarks.

For the disposal and crediting of articles of clothing bought by a man to replace others made away with, etc., see paragraph 5 of letter

P.C.
General No.
2911.

For price of time-expired articles, see paragraph 118 of these notes.

Closing of the Ledger.

169. At the end of the clothing year, 31st March, all the various accounts in the ledger being closed, and the remain struck (for necessaries see paras. 135 and 136), a Board of Survey assembles and actually counts all the stock in hand of clothing, necessaries, and sea kitt necessaries, comparing the totals, as counted, with those in the ledger, and recording them on W.O. Form 623. Of course a preliminary stock-taking is made by the battery. If from any cause the assembling of this Board is delayed, there may be discrepancies between their totals and those in the ledger caused by issues or receipts belonging to the new year. In such cases the Major attaches an explanatory memorandum giving particulars of the difference, and how it was caused. The real

ledger is retained by the battery, and a copy is prepared, carefully paged the same as the original, and in particular having same names and totals on each page. This is all ready by the end of March, and as soon as the "remains" are proved by the Board, the copy is completed; all the vouchers, the proceedings of the Board of Survey, on W.O. Form 623; the delivery vouchers from Pimlico, W.O. Form 505; and from other corps, W.O. Form 1220; and the clothing returns of "Transfers received," with the receipt vouchers from Pimlico and from other corps, W.O. Form 1220; and the clothing returns of "Transfers given," are attached to the ledger, fully enumerated on the lists given therein, and the whole sent to Pimlico. The audit generally takes a long time. "Observations" are generally first received, and then the final audit.

All alterations, recoveries, etc., now ordered are carried out at once, and special care should be taken to record in the battery copy of the audit, and in the ledger, all particulars of recoveries. The audit paper had best be kept attached to the ledger.

The ledger for the new year has been prepared in advance, to be ready for the 1st April. In the clothing stock book, the book of copies of transfer clothing returns (para. 27), the detailed account, and the necessaries ledger, care is taken to separate all entries for the year that is just closed from that now commencing.

Stock Book.

170. The clothing ledger being only the account between the Major and Pimlico, and being only really complete and useful on one day, the 31st March, the major requires some daily record of his transactions. For this purpose the stock book is kept, as described in paragraph 25*b* of the Notes published in May 1879 (a paragraph added after the appearance of the Notes in the Institution Papers). The receipts of new clothing shown in it will be the same as those shown in the ledger; the total issues of new clothing will also be the same; but in the stock book they will come according to the actual date of issue, so that the "remain" at any moment can be ascertained in five minutes, while in the ledger the latest issues, and therefore the remain, cannot be found without some hours' work; the ledger itself being only adapted to show the result of the whole year's transactions. The receipts of P.W. articles shown in the stock book will be more than those shown in the ledger at page 19, as the stock book shows the receipt of all the articles taken from the men, such receipts being not recorded in the ledger. The total issues of P.W. articles will be the same in both accounts, only in the stock book they come by date, in the ledger by the final result. The stock book will always act as a check on every transaction recorded in the detailed account (see para. 171). The receipt and issue of cases, etc., need not be recorded in the stock book, as the account under that heading in the ledger will be clear enough as a general rule. It will be a battery question whether it is worth while to show all the minor articles, chevrons, etc., in the stock account.

The stock book will have a "remain" struck and counted monthly, and care will be taken, in striking the "remain" for March, the end of the clothing year, to keep the entries for the old and the new year separate. The headings of each page will be the same as the chief entries in the ledger, Boots, Wellington, ankle, April, October; patrol, trousers, annual; biennial, tunic, headdress, coat, cape, leggings, with columns for dates and remarks; the remarks showing where any gross item will be found in the ledger.

Detailed Account.

171. Under existing regulations a man will always have in his possession some clothing besides the year's issue, the amount varying with each man. The present books give no means of quickly ascertaining what clothing each man ought to produce, especially if there has been a change of pay-sergeants; I therefore recommend the opening of a book much on the same principle as the battery cash ledger, in which each man should have a sheet to himself, and in which all issues to him, and all withdrawals of clothing from him should be recorded at the time, so that his "remain" could be struck at any moment, and should be regularly struck and proved at the end of each clothing year. The transactions recorded in this account will, of course, be identical with those in the stock book, as far as the men are concerned; while each man's annual "remain" must correspond with the clothing recorded in the nominal roll (para. 167) as in possession of the man on 31st March. The clothing taken away by a transfer, as shown on his transfer clothing return, must correspond with his "remain" at that time in the detailed account. The clothing brought by a transfer will be taken up in this account on opening the man's sheet. Notes will be made of any article made away with, and of the recovery of its value. The multiplication of books and accounts is very objectionable, but I believe that when such an account as this is not avowedly kept, at least the same amount of work it entails has to be done yearly to keep the nominal roll correctly. If the entries in this account are verified by the man's signature it will be unnecessary for him to sign the stock book. The utility of this account will greatly depend upon full explanatory notes being given of any special transactions. All entries and totals in this account should not be in figures representing the number of articles, but in the original date of issue of the article; thus, in paragraph 172 the "remain" of Gunner Elton on discharge, 1881, would not show "2" in the jacket column but '80 and '81. I find that, practically, batteries do not know what clothing a man has. They say they can find out by their ledger and stock book; so, theoretically, they can, but it is so difficult that mistakes are constantly made about transfers, especially when articles have been made away with. If this is the case with good Pay and Q.-M. Sergeants who have been working the same batteries for years, what would it be on a change of staff? This book will make the state of a man's clothing account as plain to any stranger as the battery ledger does his cash account.

The form of the account is very simple. Across the top of the sheet comes the heading for each garment and sort of boot, head-dress, great-coat, and leggings, much the same as in the man's account book. By cutting the top of the sheets one heading will do for a great many pages. Each man has a sheet to himself, as in the ledger: or, more conveniently, two pages facing one another. A broad column is left on each side, on the left for dates of issues and withdrawals, and the reason thereof, on the right for remarks. The first entry will be for "Recruit Clothing," or "Brought on Transfer," then follow the necessaries issues and withdrawals, "Annual April issue," "Withdrawn, time-expired, and useless." Withdrawals have a note to show in what page of the stock book they will be found as receipts. All articles, new or old, are entered only by their original dates of issue, so as to make it quite clear what are withdrawn and what left. A general remain should be made at end of March, or at time of any transfer, or after any withdrawal of several articles. For the October issue and withdrawal of boots a remain in that October column only can be taken. The man signs for issues, the pay-sergeant for withdrawals. Two witnesses had better sign to the first issue to recruits, to save sending the pay-sergeant away if the man is tried for fraudulent enlistment. If compensation is granted the letter C is inserted in red ink in the column that would otherwise have contained the issues, with full explanatory note: see para. 144. On discharge the issue of plain clothes, or compensation instead, is recorded: see para. 140. A specimen form is given, prepared before the recent change in the clothing year.

The detailed account, except for transfers to the battery, had better commence with the first issue under the new regulations, that is, from 1st April, 1878, and for recruits clothed with new articles in 1878, from 1st January, 1878.

Paragraph 171.—Specimen of Detailed Account.

No. 2182, Gunner Robert Balton. Transferred 12th April, 1879, from 23rd Batt. 27th Brigade, R.A.

Date.	Cause of Issue and of Withdrawal.	Boots.			Frocks.	Trousers.		Tunic.	Head-dress.	Great Coat.	Cape.	Leggings.	Signature and Remarks.
		Wellington.	Ankle.			Annual.	Biennial.						
			April.	October.									
1879.													
April 12	Brought on transfer	'78	'79	'78	'79	'79	'78	'78	'77	'77	'77		R. Balton.
,, 13	Issue to complete	...	...	...	...	...	...	...	...	...	...	'78	R. Balton.
Oct. 1	Annual issue	...	...	'79									R. Balton.
,, 3	Withdrawn, time-ex., useless	...	...	'78									C. Rolls, Serg. See p. 253, Stock.
,, 3	Remain October Boots	...	...	'79									
1880.													
April 1	Annual and Biennial issue...	'80	...	...	'80	'80	'80	'80					R. Balton.
	Total	'78-'80	'79	'79	'79-'80	'79-'80	'78-'80	'78-'80	'77	'77	'77	'78	
April 6	Withdrawn, time-ex., useless	'78	...	...	...	...	'78						C. Rolls, Serg. See p. 512, Stock.
June 30	Annual remain.....	'80	'79	'79	'79-'80	'79-'80	'80	'78-'80	'77	'77	'77	'78	R. Balton.
Sept. 30	Made away with	...	'79										Reg. C. Martial, 4 Nov., 1879. Value £ Cr. in Dec. 5/11
Sept. 30	Remain April Boots	...	Nil.										
Dec. 2	Issue to complete	...	P.W. 4, '79										R. Balton.
Dec. 15	Withdrawn	...	...	...	...	...	...	...	...	...	...	'78	C. Rolls, Segt. p. 712, Stock.
Dec. 15	Remain on transfer.....	'80	'79	'79	'79-'80	'79-'80	'80	'78-'80	'77	'77	'77		R. Balton.

Transferred to 24th Battery, 27th Brigade, R.A.

172. The practical working of the system may be best understood by a specimen case. A new patrol jacket is, for some reason, demanded and received from Pimlico in September 1879. On arrival it is duly surveyed and entered as received at page 4 of the clothing ledger (its P.C. number being given), and in the current page of the stock book. In March 1880 it is issued to Recruit Elton, as part of his annual clothing; its issue is noted in the stock book, "New" part, in the man's account book, and in his page of the detailed account. In the ledger a black "|" is put against Gunner Elton's name in the column for "Jackets" in the nominal roll. On the 31st March, 1880, when the ledger is made up, this jacket is included among a total of 144, shown as issued to men at page 11, and at page 19 as brought on as part worn from issues; it is also included at page 21 among a total of 288 "in wear," while in the man's sheet of the "Detailed Account" it is included as one of the two jackets shown as G. Elton's "remain" on the same date. In the new ledger, opened on 1st April, this jacket is included in the total remain carried on, "Part Worn," at page 19. On the 1st January, 1881, G. Elton is transferred from 18-24 to 19-24, and takes this jacket with him. No. 18-24 strike off the jacket, entering a black "'80" in the jacket column of "Taken away by Transfers" in the nominal roll of the ledger, against G. Elton's name; and carrying out that entry to the total shown at pages 27 and 21. In the detailed account a "remain" is struck in G. Elton's sheet, and the articles in his possession as recorded there, and as proved by actual inspection to be with him, are inserted in the transfer clothing return, this jacket being shown by a "|" in the jacket column, to last to 31st March, 1881. No. 19-24 take up the jacket on their charge in the same manner, entering it as a black "'80" in the jacket column of "Received with Transfers," and carrying it, on the 31st March, 1881, to the totals at pages 19 and 21. They also open a new sheet in their detailed account for G. Elton, taking up the jacket by its date "'80." At the end of March, 1881, the jacket is examined, as it has worn its full time, it is found to be still useful, and is returned to the man. On the 31st March, 1881, No. 19-24 close their ledger, and as this jacket is part of the "remain" in G. Elton's sheet of the detailed account they insert in the nominal roll the date of its original issue, "'80," in red ink in the proper column against his name; the jacket is also included among the total shown at page 21 "In wear." In July 1881 G. Elton is discharged by purchase, his detailed account is closed, and the jacket and the other articles shown in his "remain" there are entered in the stock book (P.W.) as received into store. On the 1st August, 1881, it is issued to a recruit, G. Green, and is therefore entered as an issue in the stock book, and in G. Green's "detailed account" as well as in his account book, the original date, '80, being inserted in each book. On 1st March, 1882, it is again examined, found to be useless, taken from the man and returned to store. Its withdrawal is entered in the man's detailed account, and its receipt into store in the stock book. It is then formally surveyed and condemned, authority for its return is obtained and it is sent off to Pimlico, or the Arsenal, as ordered. Its issue to Pimlico is entered in the stock book (P.W.) and in the ledger at page

27, the P.C. number of the authority being given, after which it disappears from the battery's charge, being struck off on 31st March, 1882, at page 21.

The history of any other article, helmet, great-coat, etc., would have been recorded in the same way, except that in the case of a great-coat, its first issue would have been entered in the register of great-coats (para. 28), where each subsequent change of wearer, or return into store, would have been noted.

Clothing.—Foreign Stations.

173A. A battery going to or returning from India has to prepare for the survey of the clothing that will take place by the Board consisting of the representatives of the English and Indian Governments. Full details will be found in the Equipment Regulations, Appendix I., pages 147 to 149, as altered by Army Circulars 190 of November 1878, and 197 of September 1879. This last Circular, 197 of 1879, must be specially studied by such battery, going or returning.

A battery going to India can take a supply of necessaries with it: for details see A.C. 25 of 1875, and appendix, as altered by A.C. 8 of 1876, also para. 9 of A.C. 197 of 1879.

For clothing required on arrival in India, see A.C. 193 of 1877, para. 3.

For helmets required for embarking for India, see A.C. 193 of 1877, paras. 1 and 2.

Private arrangements for the supply of boots or any clothing for troops embarking for India are forbidden by A.C. 79 of 1879.

For helmets of batteries on foreign stations proceeding to India, see A.C. 193 of 1877, para. 4.

173B. For white clothing at Hong Kong, Ceylon, and Straits Settlements, see A.C. 34 of 1879, paras. 3 and 4.

173C. For clothing at foreign stations, except India, see A.C. 27 of 1877, as altered by 34 of 1879.

Equipment.

174. The Equipment Regulations of 1876 (Revised Army Regulation, Vol. III.) give full particulars of the management of the arms, accoutrements, and musical instruments of a garrison battery. Unfortunately they have been altered by a number of clauses in the Army Circulars, and they are still being so altered, that the original regulations almost disappear in the variations. A list of most of the clauses altering these regulations will be found in paragraph 201 of these notes. The words Eq. page 40, or Eq. para. 352, are here used for reference to pages or paragraphs of the Equipment Regulations.

175. Let us take the case of a battery just raised, or that has come home without its equipment. A full set of arms and accoutrements has to be drawn for each man, except that sergeants have no ball bag; and that trumpeters have no carbine, ball bag, or pouch, receiving instead a trumpet and a bugle with strings. When drawn every article of each stand of arms and set of accoutrements has to be marked with a certain battery number, one of a consecutive series, from one upwards; this same number being on all the articles of arms and accoutrements in possession of one man. The battery mark and the date of issue has to be on large articles. Once received by the battery the equipment remains always in charge of the Major, whether the articles are issued to the men or remain in store. The Major, however, has not to make good any loss or damage occasioned by the men, unless he can recover the amount from them, except in cases of damage that he ought to have prevented or to have covered by stoppages at the time. Thus G. Smith deserts with a waist-belt, the Major is not responsible. G. Brown injures his belt and is discharged before the damage is discovered, the Major is responsible. See Eq. paras. 9 and 10.

176. Carbines and sword-bayonets are demanded (Eq. para. 28) direct from the Commissary-General at the station, on W.O. Form 443 in duplicate, in accordance with the scale of equipment given at page 90 Eq., as altered by Errata issued with clause 131, A.C. of 1st June, 1879. As a garrison battery has no means of marking arms, a separate application is made at the same time to have them marked by the Ordnance Department before issue, in a battery series from 1 upwards, with the distinctive marks ordered by Errata issued with clause 131, A.C. 1st June, 1879, articles 282 to 288, and pages 12, 15, and 16. Note that the numbers of the stand of arms do not ever rise higher than the highest number of stands with the battery at one time, not like the consecutive brigade numbers given to men. Thus stands of arms replacing others take the old numbers; a new No. 8 carbine replaces the old No. 8. On receipt of notice that the arms are ready for issue, enquiry should be made whether this marking has been done, as the garrison artillery being an exception to the general rule that the corps affix their own distinctive marks, this may be overlooked.

177. Trumpets and bugles with their strings (Eq. page 142) are demanded in the same manner, on W.O. Form 469 in duplicate. They are marked by the battery, after receipt, with the battery distinctive mark; and with the date of issue, if that has not been done by the Ordnance Department. For recovering expense, see Eq. para. 300. They are also marked as first or second set. An armourer can generally be found to do this.

178. Accoutrements, in which are included all the valise equipment, water-bottles, oil-bottles, and havresacks, are demanded, in the same manner, on W.O. Form 452 in duplicate, except when few articles are required, when W.O. Form 1456 for equipment, or 1457 for material for repair, are used (Eq. paras. 37 and 38). Demands for few articles can

be made in manuscript if the proper forms are not in hand, A.C. 177 of 1877. For establishment, see Eq. page 90, altered by Eq. Errata issued with A.C. of 1st June, 1879. Before issue the Ordnance Department mark the date of issue on each article (Eq. para. 289). Note that all articles of equipment do for any man, except the "braces" of the accoutrements, which are issued in four sizes, as follows: L., large, men over 5 ft. 11 in.; M., medium, men 5 ft. 9 in. to 5 ft. 10 in.; M.S., medium small, 5 ft. 7 in. to 5 ft. 8 in.; S., small men, under 5 ft. 7 in. A battery generally requires about the following proportions; a quarter large; half, medium; rest, medium small. The proportion given in G.O. 62 of 1878, Instructions, page 2, is not suited for artillery. In the case of a battery receiving valise equipment for the first time, see paragraph 185 of these notes, and General Order 62 of July 1878.

179. An arm chest (see Changes in Material, 3616 of 1st Nov., 1879) is demanded on W.O. Form 1456, see A.C. 127 of 1875, and 99 of 1878. For its care see Ordnance Stores Regulations, para. 436, and 455 to 468.

180. Handcuffs, one pair (see Eq. page 143), are demanded in the same manner on W.O. Form 1456 in duplicate.

181. Stamps for marking the accoutrements are demanded on W.O. Form 1456, for establishment, see Eq. page 145.

182. On receipt the cases containing the supply are examined to see if they have been opened. If the delivery vouchers have not been received, the cases are weighed to see if they are of the same weight as is marked on them: see Eq. paras. 46 to 48. The cases are retained till the arrival of the regular delivery and receipt vouchers. The carrier's note is signed and returned to the address given on it, as it is a mere acknowledgment of the receipt of the cases in good order. When the vouchers arrive the cases are opened in the presence of the commanding officer (Eq. 41), but still better in that of a Garrison Board (Eq. para. 76); the articles are carefully counted (the numbers being compared with the delivery voucher), examined by an armourer and proper tradesmen, and fitted together. See Eq. paras. 41 to 49, especially 43 and 48.

183. If all is correct the full detail of the stores is entered in the equipment ledger (para. 25) in exact agreement with the delivery vouchers. The delivery and receipt vouchers are then carefully compared. The delivery vouchers are firmly clipped to the ledger, to accompany it to the Arsenal for audit at the end of the year; the receipt vouchers are signed and returned to the Commissary-General issuing the stores. The arm chest having been entered as a receipt at page 2, Receipts, is written off at page 2, Issues, as an issue. See A.C. 127 of 1875.

184. The packing cases are brought on charge at page 6, Receipts, of the ledger, but they should soon be returned to the Department, regular delivery and receipt vouchers, W.O. Form 1220, being sent with them (see Regulations Ordnance Stores Department, page 18, para. 112, and also page 31, para. 222), while their issue is recorded at page 6, Issues, of the ledger. The receipt voucher when returned, signed, by the Commissary-General, is clipped to the ledger to eventually accompany it for audit. See Eq. paras. 65 to 72. Care should be taken to keep the cases received from the Ordnance Department separate in store from those sent by the Clothing Department. See Army Circular 113 of 1876.

185. All the articles of equipment received, except the arms, have now to be marked. The accoutrements and musical instruments are marked in accordance with Eq. paras. 272 to 275 and 289 to 300 (arms, if done, under Errata issued with Army Circular of 1st June, 1879, clause 131), so that any article, except some too small to bear all the marks, can at once be identified as belonging to the battery and to a certain stand of arms (or set of accoutrements) in the battery. For cost, see Eq. paras. 298 and 299. As the "braces," however, are not interchangeable, it will save trouble, in the case of a battery receiving its first supply of valise equiqment, not to mark the braces until they have been actually tried on the men, and until it is quite certain the proportion received of the different sizes will do. (See General Order No. 62 of July 1878, instructions fitting valise equipment, especially para. 7.) The proportion of sizes for braces given in paragraph 3 of the order are not suited to the artillery, see para. 178 of these notes.

186. Before issue to the men the description of each set of arms and accoutrements is entered in detail in the register of arms (para. 41), ample space being left for the names of all the men that may in subsequent years receive the set, and also for the entry of other articles, replacing those of the first issue, lost, destroyed, or returned as unserviceable. Leggings, although accounted for as clothing, and never shown on the equipment ledger, are generally, for convenience, numbered with the stand of arms, so that a man's equipment and leggings all bear the same number. See paragraph 129, and also see Ordnance Stores Department Reg. para. 488, and A.C. 15 of 1880, page 33.

187. On issue to the men, whether for the first time, or on any set changing hands, each article is examined by the Sergeant-Major in the presence of the man who is to receive it: the man himself is given full liberty, or rather is *made*, to examine every article in detail; while he is warned that any damage not noted at the time will be charged against him. All defects and special marks are noted in the register. The name of the man receiving the set and the date of issue to him is entered in the register, and the number of the set is entered against the man's name in the squad book of his sub-division. Recruits should be specially warned not to make fresh holes in their belts or braces, but to take them to the Sergeant-Major if any alteration is required. Special

inspection of recruits' sets should be made from time to time, to see that no damage is done to the arms or accoutrements, see G.O. 50 of 1880.

188. Once a week, at kitt inspection, the arms and accoutrements ought to be examined, as well as at the monthly inspection on muster day. A special examination ought also to be made after any move, whether of the whole battery or of any detachment, more particularly after any voyage, however short. See Ordnance Stores Department Regulations, para. 471. Before leaving any station care should be taken to see that there has been no accidental interchange of articles with other batteries. See also para. 198 of these notes.

189. Once a quarter the arms should, whenever practicable, be passed through the hands of an armourer, who is allowed for the purpose one-sixteenth of a pint of oil for every 18 stand of arms, taken from the annual allowance of oil. The knowledge that a frequent examination will be made stops much carelessness. See Eq. page 99, as altered by Errata on Equipment issued with clause 131 of A.C. of June 1879, page 9.

190. Once a year all the articles of equipment, arms, musical instruments, accoutrements, &c., especially frogs and havresacks, are carefully inspected: a few sets being called into store at a time, or only brought up by the men, as convenient. All the marks on each article are compared with the description in the register of arms; and those that are getting too faint are re-marked. An annual allowance of one pint of oil for every 18 stand of arms, and of two and a-half ounces of old sheeting for each carbine, is authorized by Eq. page 99, drawn on the 1st March on W.O. Form 1456.

Repairs.

191. The leather work of the accoutrements is repaired by the battery shoemaker, or special tradesman, from time to time, under Eq. para. 330. Three shillings per quarter is drawn on W.O. Form 1090, for valise equipment, for this work. Small losses and damages are not made good at the time (Eq. para. 32) by special demands; but a general requisition is, if necessary, sent in on the 1st of March, June, September, and December: on W.O. Form 1456 for articles of equipment, 1457 for articles for repairs. (Eq. paras. 29 and 31.) The battery draws annually on 1st March (Eq. 29), on W.O. Form 1456 in duplicate, the yearly allowance of oil and old sheeting (Eq. page 99), and on W.O. Form 455, certain articles (Eq. page 100) for the repair and completion of the accoutrements. These articles, when received, are regularly brought on charge in the ledger; and then shown as expended, as far as they are really used, the issue being vouched for as at page 174 Eq.: see Eq. page 150, para. 5. Articles not named at page 100 Eq. are demanded when necessary on W.O. Form 1456.

For repairs to arms, see Eq. paras. 323 to 329; accoutrements, Eq.

paras. 330 to 335; trumpets, bugles, Eq. para. 336. For replacing losses by neglect or by carelessness, see Eq. paras. 93 to 95, as altered by Errata issued with A.C. of 1st January, 1877, clause 10, Eq. para. 33, and Eq. paras. 77 to 83. Plugs of water-bottles when lost are replaced by the battery, see Eq. para. 141. The prices of all articles of equipment are given in the priced vocabulary issued to batteries.

192. Once in two years the carbines are browned by an armourer (Eq. para. 325), who is not paid for the work (Eq. para. 329), but who is allowed two assistants, who receive pay at the rate of 1d. an hour (Eq. para. 328, and articles 791 and 794 of the Pay Warrant). The materials are demanded according to the scale laid down at page 99 Eq., as altered by Errata issued with A.C. 1st June, 1879, page 9, from the Commissary-General on W.O. Form 459 in duplicate; the demand properly being made by the corps whose armourer does the work.

193. If any article becomes unfit for service, a Garrison Board of Survey (Eq. para. 76) is applied for, and, if they condemn it, authority to return it is requested from the Commissary-General, the proceedings of the Board (W.O. Form 263) being given in support. The time for duration of the equipment is given at pages 56 and 57 Eq., as altered by A.C. of 1st June, 1877. For trumpet and bugle strings see A.C. 126 of 1873, article 27. For returning articles into store see Eq. paras. 51 to 73 (especially 56, 59 and 71), also 137.

194. When a set of arms and accoutrements are taken from a man for any reason, careful examination should be made of all articles composing the set, and any damage charged for at once. In the case of transfers from the battery a preliminary examination should be made as soon as it is known the man is likely to leave; the set being finally withdrawn as soon as practicable. In the case of deserters or absentees the same examination should be made, and immediate note should be made in the ledger of any loss, and in the register of arms of any loss or damage to the set.

195. Batteries about to embark for India, or returning from India to England, should pay special attention to the preparation for the survey on their equipment that will take place in England as detailed in Eq. pages 147 to 149, Appendix I. to para. 84, altered by A.C. 190 of November 1878 and 197 of September 1879. The register of arms, if properly kept, will be most useful for this purpose. A special comparison of all articles of equipment with the register should be made a short time before the survey is held, and care should be taken to collect all articles, especially belts, as men are sometimes absent on pass.

196. Articles taken away by deserters are accounted for by being entered in the ledger, supported by vouchers, as shown at page 175 Eq.

197. Ammunition expended is accounted for as shown at page 150 Eq. para. 9.

198. When any men of other corps leave the battery, who have been living in its quarters, or who have been attached to it, care has to be taken that they do not, by mistake, carry off any articles of the battery's equipment instead of their own. Even when on mixed guards, exchanges sometimes take place.

Closing the Ledger.

199. By the end of March the ledger is ready to be closed, for details of which see Eq. pages 149 to 151, Appendix II., reading 31st March for 31st December as ordered by Errata issued with A.C. 64 of 1877, and 103 of 1877. Specimen sheets of the ledger will be found at pages 163 to 171 Eq., and vouchers at pages 172 to 175 Eq. The necessary notes of losses, &c., are made, and a fair copy of the ledger is prepared, omitting all notes intended only for battery use. On the 31st March the ledger is finally closed, the remain is struck, and is tested by comparison with the register of arms (para. 41). The vouchers are clipped to the fair copy, which is sent off for audit to the Commissary-General, Royal Arsenal, Woolwich, direct, if at home, or if on foreign station (not India) to him through the Commissary-General of Ordnance at the station. In due time the observations on audit are received, and they are at once complied with and answered quickly; the battery copy being attached to the Eq. ledger. If any recoveries, etc., have to be carried out, a note that the sums have been recovered and credited, and in what pay list, should be made on the copy of the observations.

200. Three-pence for each rifle per quarter is deducted from the Major's contingent, and credited quarterly on W.O. Form 140.

Note.—These notes were written in November 1879, and are only partially altered to suit later Circulars.

EXPLANATORY NOTES ON PROF. A. G. GREENHILL'S PAPER "ON THE ROTATION REQUIRED FOR THE STABILITY OF AN ELONGATED PROJECTILE."

BY

CAPTAIN J. P. CUNDILL, R.A.

The valuable and interesting paper published by Prof. Greenhill in the R.A. Institution "Proceedings" for September, 1879 (Vol. X., No. 7), has attracted much attention.

It has occurred to me that, seeing the intricacy of the subject, and the high nature of the mathematical reasoning involved in its solution, without attempting to go into the more recondite parts of the reasoning, it might be useful to give a few explanatory notes pointing out the hypotheses assumed, the problem to be investigated, and the conclusions arrived at. The notes have been submitted to Prof. Greenhill, and, indeed, are in great part given in his own words, noted down by himself on an occasion of our going through his article together, with a view to the production of this short paper.

First, then, as to the hypotheses assumed. A body having the form of a prolate spheroid is supposed to move in a frictionless and homogeneous (*i.e.* incompressible) medium in the direction of its longer axis. Gravity is neglected, and hence the curvature of the trajectory and the "drift" do not enter into the scope of the paper. In the earlier parts of the reasoning the body is supposed to be solid, but suitable adaptations are subsequently made which allow the special cases of hollow bodies, or shells, to be considered, and numerical calculations to be made for them. It is necessary to assume that the body has a spheroidal form, and that the medium is frictionless and incompressible; as hitherto mathematicians have succeeded in solving the problem of discovering the "stream lines," and the consequent state of motion of the surrounding medium, only in the case of an

ellipsoid* (of which the spheroid is a particular case) moving in a frictionless and incompressible medium.

The prolate spheroid is the form assumed in the present instance, as it most nearly resembles that of an ordinary elongated projectile. Throughout the paper the centre of gravity is supposed to be coincident with the centre of figure—*i.e.*, in the centre of the longer axis.

Secondly, as to the problem to be investigated. If a projectile left the bore of a gun perfectly truly centred, and perfectly true in form, then, *under the assumptions described above*, it would require no spin at all. If, however, gravity be taken into account—as must necessarily be the case in practice—it is absolutely necessary to give spin, even in the case of the other assumed conditions remaining unaltered. The axis of the shot being, immediately after it leaves the bore, inclined to the tangent to the trajectory, the shot would turn over were it not kept in stability by its rotation. In an analogous manner, a perfectly-formed top ought theoretically to stand on its point without being spun. Practically we cannot make a top do so.

Supposing it to be possible to succeed in making the top stand on its point, or the projectile fly properly through the medium, without giving them spin, they would obviously be in a condition of highly unstable equilibrium. We have, then, to find out how much spin it is necessary to give the projectile to convert this unstable into stable equilibrium.

If we spin a top with considerable angular velocity on a table, we find that its longer axis is at first, as a rule, by no means upright, but that this axis will describe a series of cones having the point as a common vertex. The vertical angle of these cones becomes smaller and smaller till the axis of the top is upright, and the top "sleeps." This effect is produced by the friction of the point on the table.

In a similar manner a projectile describes a helical course round the mean trajectory, and, our hypothesis assuming the surrounding medium to be frictionless, it continues to preserve this helical motion throughout its flight; though in practice the friction of the air reduces this motion, and tends to keep the longer axis of the projectile truly in the line of the mean trajectory, or (as far as the helical motion is concerned) to make the projectile "sleep," like the top.

Returning to the top, which we suppose to be "sleeping." After a time, the friction of the point on the table and other causes reduce the angular velocity to such an extent that the top begins again to describe cones with its longer axis about the point as a vertex, the spin now being insufficient to keep that axis in stable equilibrium. The angular velocity which is just sufficient to keep the top "asleep" instead of

---

* The ellipsoid is a solid generated by a variable ellipse which moves parallel to itself, with its axes in two fixed planes and with its vertices in two ellipses in those planes, having a common axis coincident with the intersection of the planes. The spheroid is a particular case of the ellipsoid, in which the variable ellipse becomes a variable circle. It may also be generated by the revolution of an ellipse about one of its axes. The prolate spheroid is that generated by the revolution of an ellipse about its major axis.

allowing it to wabble is analogous to the angular velocity required to keep the projectile in stable equilibrium, point foremost; and this is the point elucidated in Prof. Greenhill's paper.

The amount of spin is calculated in the customary notation of one turn in n calibres, and it will be shown that this is the correct way of reckoning it.

It will now be well to make a few remarks on various points contained in Prof. Greenhill's paper. (The marginal references refer to that paper.)

The symbols c_{11}, c_{33}, c_{44}, c_{66} may be replaced by c_1, c_3, c_4, c_6; the double suffix being only required when an unsymmetrical body is dealt with, which is not the case in the present paper. Page 577. 2nd line of 3rd para.

The state of motion set up in the surrounding medium is considered by means of the component *linear* velocities u, v, w of the body, taken separately, and also by means of the component *angular* velocities p, q, r of the body, taken separately. (Note that the angular velocity r round the longer axis of the body does not impart motion to the surrounding medium, as the latter is assumed to be frictionless.) Page 577. 4th para.

When the body has the velocity u its energy is $\frac{1}{2}Mu^2$ (M being weight of body in lbs.), and the energy of the medium will be proportional to u^2, to ρ (the density of the medium), and to the volume of the body; *i.e.*, the energy of the medium will be proportional to u^2 and to M' (the weight of medium displaced). Hence

$$\begin{aligned} \tfrac{1}{2}c_1u^2 &= \tfrac{1}{2}Mu^2 + \tfrac{1}{2}\alpha M'u^2 \text{ (where } \alpha \text{ is some constant)} \\ &= \tfrac{1}{2}Mu^2\left(1 + \frac{M'}{M}\alpha\right) \\ &= \tfrac{1}{2}Mu^2\left(1 + \frac{\rho}{\sigma}\alpha\right), \\ \therefore\ c_1 &= M\left(1 + \frac{\rho}{\sigma}\alpha\right). \end{aligned}$$

On the assumptions made above, of the medium being frictionless and incompressible, α will be a function of the *external shape* of the body only, and $\frac{\rho}{\sigma} = \frac{M'}{M} = \frac{\text{weight of displaced air}}{\text{weight of body}}$.

The great mathematical difficulty of the investigation consists in the determination of α. Hitherto, as stated above, it has only been determined for an ellipsoid, which includes the spheroid.

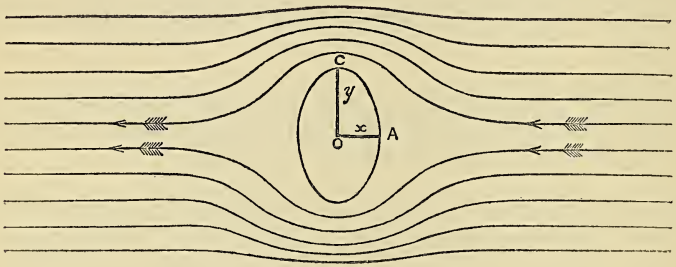
Precisely similar reasoning and remarks apply to γ. Page 588. 1st para.

To determine α and γ, it is necessary to find the "stream lines" of the medium. The latter is first supposed to flow past the spheroid fixed.

To determine α, the medium is supposed to flow with a velocity u in a negative direction perpendicular to the longer axis of the spheroid.

To determine γ, the medium is supposed to flow with velocity w in the direction of the longer axis.

The "stream lines" have been more than once referred to. The accompanying sketch may serve to show, to some extent, what is meant by them.



The various lines of the flowing medium are parallel at an infinite distance to the right and left of the fixed spheroid. On approaching that obstacle they are deflected. No line can pass through it, and consequently they must all pass round it. The lines which would strike the centre of the spheroid are most deflected; those above and below them to a less extent. After rounding the obstacle, they tend again to resume their parallel courses.

The amount of deflection of these "stream lines" being known, it is then possible to calculate the velocity at any point of the medium.

In the above we suppose the medium to be flowing with velocity u. Now suppose the medium to be originally at rest, and the spheroid to move with velocity u. Thus we obtain the resulting motion in the medium by superposing a positive velocity u at any point of the previous state of motion, when the body was supposed to be fixed and the medium to move.

The velocity at any point of the medium is now known, the body moving with velocity u, and hence the whole kinetic energy in the medium can be calculated. The quantity α is the ratio of the kinetic energy of the external medium to the kinetic energy of a body producing the motion of the medium; this body being supposed to have the same density as the medium, and the same external shape and motion as the actual body. A similar remark applies to γ.

The mathematical work of determining α, and similarly of determining γ, is omitted, as too intricate and laborious.* The results only are given.

Page 578. Formulæ for C and A. It may be remarked that in establishing the formulæ for the values

* The subject may be found treated at length in "Green's Mathematical Papers," edited by the Rev. N. M. Ferrers.

of C and A, and thence of α and γ, we require the semi-axes of the confocal spheroids of the medium enveloping the body. These semi-axes are denoted by the expressions $\sqrt{c^2+\lambda}$ and $\sqrt{a^2+\lambda}$; c and a being the semi-axes of the spheroidal body.

The method of obtaining the value of c_{44} (or, as it may be written, c_4) is also omitted, on account of its intricacy.* It will, however, be seen subsequently that c_4 may be put as equal to Mk_1^2—*i.e.*, the moment of inertia of the body about an equatoreal axis. This means that the motion of the medium due to the angular velocities p and q of the body need not be taken into account, any more than that due to r, which, as previously noted, is nil. Page 578. Formulæ for value of c_4.

The expression "lines fixed in space" may be put more fully as "lines fixed in direction in space." Page 578. Last line.

Passing now over the somewhat intricate calculations contained in pages 579–583, and only noting that the symbols $\dot{x}, \dot{y},$; $\ddot{x}, \ddot{y}$, &c., are respectively the same as $\frac{dx}{dt}, \frac{dy}{dt}$; $\frac{d^2x}{dt^2}, \frac{d^2y}{dt^2}$, we come to the fundamental equation

$$\sin\alpha\left\{c_4\cos\alpha\mu^2 - c_6 r\mu + F^2\left(\frac{1}{c_3}-\frac{1}{c_1}\right)\cos\alpha\right\} = 0.$$

If $\sin\alpha = 0$, the conditions of perfect centring and of perfect projectiles are attained. (For remarks on this state of things, see above.) We thus come to the equation

$$c_4\cos\alpha\mu^2 - c_6 r\mu + F^2\left(\frac{1}{c_3}-\frac{1}{c_1}\right)\cos\alpha = 0;$$

which represents the state of things given by the helical path which the projectile actually describes.

This equation, then, gives the solution of the original problem—viz., "How much spin is necessary to ensure stability in flight?"

Solving the equation for μ, we find that

$$\mu = \frac{rc_6 \pm \left\{r^2c_6^2 - 4c_4F^2\cos^2\alpha\left(\frac{1}{c_3}-\frac{1}{c_1}\right)\right\}^{\frac{1}{2}}}{2c_4\cos\alpha}.$$

Hence, to give real values of μ,

$r^2c_6^2$ must not be less than $4F^2\cos^2\alpha c_4\left(\frac{1}{c_3}-\frac{1}{c_1}\right)$,

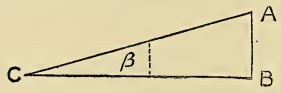
or r^2 " " " $4F^2\cos^2\alpha\frac{c_4}{c_6^2}\left(\frac{1}{c_3}-\frac{1}{c_1}\right)$;

* For details of this method see Ferrers, in "Quarterly Journal of Mathematics," 1874.

and, substituting for $F \cos \alpha$ its value $(c_3 w)$ found in equation (10) in text, it results that

$$r^2 \text{ must not be less than } 4w^2 \frac{c_3 c_4}{{c_6}^2}\left(1 - \frac{c_3}{c_1}\right).$$

It is to be noted that μ is the angular velocity with which the plane passing through the mean line of flight, or central line of the helical path, and a line parallel to the longer axis of the projectile rotates.



Now, in the right-angled triangle ABC, if AB = the circumference of the bore of a gun, and CB = the linear distance of translation in which the projectile would, from the rifling, make one revolution with a given twist of one in n calibres, then β is the angle which the rifling makes at the muzzle with the axis of the bore. Hence

$$\tan \beta = \frac{AB}{BC} = \frac{\pi d}{nd} = \frac{\pi}{n}.$$

Also, if AB represent the linear velocity of rotation of a point on the exterior of the projectile, and CB represent the linear velocity of translation,

$$\tan \beta = \frac{AB}{BC} = \frac{\frac{1}{2}dr}{w} = \frac{rd}{2w}.$$

Hence $$\frac{\pi}{n} = \frac{rd}{2w}, \text{ and } n = \frac{2\pi w}{rd}.$$

Now, $$r^2 \text{ must not be less than } 4w^2 \frac{c_3 c_4}{{c_6}^2}\left(1 - \frac{c_3}{c_1}\right),$$

therefore the minimum value of n is given by the equation

$$n^2 = \frac{4\pi^2 w^2}{r^2 d^2}$$

$$= \frac{4\pi^2 w^2}{d^2} \cdot \frac{{c_6}^2}{4w^2 c_3 c_4} \cdot \frac{c_1}{c_1 - c_3} \ *$$

$$= \frac{\pi^2 \cdot c_1 {c_6}^2}{4a^2 c_3 c_4 (c_1 - c_3)} \text{ (for } d = 2a).$$

---

* Note the disappearance of the factor w, representing the muzzle velocity.

Again, $c_1 = M\left(1 + \frac{\rho}{\sigma}\alpha\right)$, and $c_3 = M\left(1 + \frac{\rho}{\sigma}\gamma\right)$;

* $c_4 = Mk_1^2\left\{1 + \frac{\rho}{\sigma}\cdot\frac{C-A}{C-A+\frac{c^2-a^2}{c^2+a^2}(C+2A)}\right\}$, and $c_6 = Mk_3^2$.

Hence $$n^2 = \frac{\pi^2 M\left(1+\frac{\rho}{\sigma}\alpha\right)\times Mk_3^4}{4a^2 M\left(1+\frac{\rho}{\sigma}\gamma\right)\times Mk_1^2\left(1+\frac{\rho}{\sigma}\alpha'\right)\times M\frac{\rho}{\sigma}(\alpha-\gamma)},$$

where $$\alpha' = \frac{C-A}{C-A+\frac{c^2-a^2}{c^2+a^2}(C+2A)},$$

$$= \frac{\pi^2 k_3^4}{4a^2 k_1^2 \frac{\rho}{\sigma}(\alpha-\gamma)}\cdot\frac{1+\frac{\rho}{\sigma}\alpha}{\left(1+\frac{\rho}{\sigma}\gamma\right)\left(1+\frac{\rho}{\sigma}\alpha'\right)}$$

$$= \frac{\pi^2 k_3^4}{4a^2 k_1^2 \frac{\rho}{\sigma}(\alpha-\gamma)}\cdot\frac{1}{1+A\frac{\rho}{\sigma}+B\left(\frac{\rho}{\sigma}\right)^2+C\left(\frac{\rho}{\sigma}\right)^3+\&c.},$$

where A, B, C are some coefficients,

$$= \frac{\pi^2 k_3^4}{4a^2 k_1^2}\cdot\frac{1}{(\alpha-\gamma)\left\{\frac{\rho}{\sigma}+A\left(\frac{\rho}{\sigma}\right)^2+B\left(\frac{\rho}{\sigma}\right)^3+\&c.\right\}}.$$

But as, for metal projectiles, $\frac{\rho}{\sigma}$ is obviously a very small quantity (being in the case of a cast-iron common shell less than ·00025), the square and higher powers of $\frac{\rho}{\sigma}$ may be neglected.

Hence the formula becomes

$$n^2 = \frac{\pi^2 k_3^4}{4a^2 k_1^2 \frac{\rho}{\sigma}(\alpha-\gamma)}.$$

Let us, however, work out the value of n for (say) the Martini-Henry bullet from the exact formula

$$n_1^2 = \frac{\pi^2 c_1 c_6^2}{4a^2 c_3 c_4 (c_1 - c_3)},$$

---

* It is hardly necessary to remind the reader that the moment of inertia (usually denoted by Mk^2) of a rigid body about a given axis is the sum of the products of the mass of each particle of the body and the square of the distance of that particle from the axis. The radius of gyration (k) of a body about a given axis is the distance of a point from the axis at which, if the whole mass were collected, the moment of inertia would be the same as before.

and see how much it differs from the value obtained by the *approximate* formula given above.

In this case, $c = 3a$, $\frac{c^2 - a^2}{c^2 + a^2} = \cdot 8$,

$a^3 C = \cdot 0725$, $a^3 (C - A) = -\cdot 2246$,

$a^3 A = \cdot 2971$, $a^3 (C + 2A) = \cdot 6667$,

$a = \cdot 80385$,

$\gamma = \cdot 12201$,

and $\frac{\rho}{\sigma} = \frac{1}{10 \cdot 4 \times 816}$.

Now,
$$c_4 = Mk_1^2 \left\{ 1 + \frac{\rho}{\sigma} \cdot \frac{C - A}{C - A + \frac{c^2 - a^2}{c^2 + a^2} (C + 2A)} \right\}$$

$$= Mk_1^2 \left(1 - \frac{1}{10 \cdot 9 \times 816} \times \frac{\cdot 2246}{\cdot 8 \times \cdot 6667 - \cdot 2246} \right)$$

$$= Mk_1^2 \left(1 - \frac{\cdot 2246}{10 \cdot 9 \times 816 \times \cdot 3088} \right)$$

$$= Mk_1^2 \times \cdot 99991823.$$

Hence
$$n_1^2 = \frac{\pi^2 k_3^4 \left(1 + \frac{\rho}{\sigma} a \right)}{4a^2 \left(1 + \frac{\rho}{\sigma} \gamma \right) k_1^2 \times \cdot 99991823 \times \frac{\rho}{\sigma} (a - \gamma)};$$

$$\therefore \frac{n_1^2}{n^2} = \frac{1 + \frac{\rho}{\sigma} a}{1 + \frac{\rho}{\sigma} \gamma} \times \frac{1}{\cdot 99991823}$$

$$= \frac{1 + \frac{\cdot 80385}{10 \cdot 9 \times 816}}{1 + \frac{\cdot 12201}{10 \cdot 9 \times 816}} \times \frac{1}{\cdot 99991823}$$

$$= \frac{1 \cdot 00009038}{1 \cdot 00001372} \times \frac{1}{\cdot 99991823}$$

$$= 1 \text{ very nearly.}$$

Thus we see that the *approximate* formula given for the value of n is, for all practical purposes, the same as the *exact* formula, when dealing with projectiles made of material possessing considerable density.

General Conclusions.

From the formula obtained for the value of n we derive the following conclusions; bearing, however, in mind that the article deals only with stability of rotation, not with other matters affecting the shooting of a gun:—

1. The twist required to be given to the rifling of a gun is, for similar projectiles of the same material, independent of the calibre of the gun when the twist is given in the usual form—viz., one turn in n calibres.

In other words: if a given gun has twist enough to give stability of rotation to a given projectile, any other gun firing similar projectiles of the same material will also give sufficient stability to its projectiles, provided the twist of the rifling of the guns, reckoned in calibres, be the same.

We thus see that the usual form of expressing the twist of rifling as one turn in so many calibres is a truly mathematical one.

2. It matters not whether the rifling have an uniform or an increasing twist, as far as giving stability of rotation to the projectile is concerned. Obviously the projectile leaves the bore of the gun with the angular velocity due to the rifling at the muzzle; and in this respect it is indifferent whether the rifling has the twist at the muzzle all through the bore, or whether the twist gradually increases towards the muzzle. Hence, also, in this respect the length of the gun is immaterial.

3. Differences of muzzle velocity make no difference in the twist required to give stability of rotation, on the hypotheses of incompressibility and absence of friction in the medium. If a gun with muzzle velocity V gives sufficient spin to its projectile, then that gun will give sufficient spin to that projectile when the latter has a muzzle velocity either less or greater than V. It is true that an increased velocity of translation requires a greater velocity of rotation, but the additional velocity of rotation required increases in precisely the same ratio as the velocity of translation increases. Obviously the angular velocity varies directly as the linear velocity; thus the two go, as it were, hand-in-hand, whatever be the value of V.

An error has crept in here. The effect of increase of spin is not to diminish but to increase drift. There are considerations which render it desirable for ordnance fired at a high angle to have a quick twist; but as far as stability of rotation of the projectile is concerned, the quicker twist in howitzers is not necessary. Page 589.

The density (10·9) here given is that of the Martini-Henry bullet, which contains 12 parts of lead and 1 part of tin by weight. Page 591.

Appended is a table which may prove useful. It requires no explanation. The value of $\alpha - \gamma$ is given in each case, as the calculation of that factor is the most laborious part of any calculation for the value of n. Knowing these values of $\alpha - \gamma$, it is very easy to calculate n for any special projectile of a kind not given in the table.

Table calculated from Prof. Greenhill's Formula for Stability of Rotation of Projectiles.

(R.A.I. "Proceedings," Vol. X., p. 586.)

Length of projectile in cals.	Value of $\alpha - \gamma$.	Minimum twist at muzzle of gun requisite to give stability of rotation = 1 turn in n calibres.			
		Cast-iron common shell: Cavity = $\frac{8}{27}$ths vol. of shell. (s.g. of iron = 7·207)	Palliser shell: Cavity = $\frac{1}{8}$th vol. of shell. (s.g. = 8·000.)	Solid steel bullet. (s.g. = 8·000.)	Solid lead and tin bullets of similar compn to M.-H. bullets. (s.g. = 10·9.)
		Value of n.	Value of n.	Value of n.	Value of n.
2·0	·49418	63·87	71·08	72·21	84·29
2·1	·52032	59·84	66·59	67·66	78·98
2·2	·54431	56·31	62·67	63·67	74·32
2·3	·56643	53·19	59·19	60·14	70·20
2·4	·58679	50·41	56·10	57·00	66·53
2·5	·60561	47·91	53·32	54·17	63·24
2·6	·62315	45·65	50·81	51·62	60·26
2·7	·63938	43·61	48·53	49·30	57·55
2·8	·65454	41·74	46·45	47·19	55·09
2·9	·66868	40·02	44·54	45·25	52·72
3·0	·68192	38·45	42·79	43·47	50·74
3·1	·69434	36·99	41·16	41·82	48·82
3·2	·70598	35·64	39·66	40·30	47·04
3·3	·71693	34·39	38·27	38·84	45·38
3·4	·72724	33·22	36·97	37·56	43·84
3·5	·73697	32·13	35·75	36·33	42·40
3·6	·74615	31·11	34·62	35·17	41·05
3·7	·75483	30·15	33·55	34·09	39·79
3·8	·76303	29·25	32·55	33·07	38·61
3·9	·77082	28·40	31·61	32·11	37·48
4·0	·77820	27·60	30·72	31·21	36·43

APPENDIX A

OF

PROPOSED LIMBER SYSTEM FOR FIELD ARTILLERY.

BY

MAJOR W. B. E. ELLIS, R.A.

Should it ever come to pass that, by the adoption of a thoroughly efficient organisation, the transport train should no longer be the "drag" on all military movement, it is most desirable that modern light artillery be not then saddled with the name of *impedimenta;* and as some objections have been made against the experimental limber on account of the extra number of rounds it would carry, it may be that this limber would be improved were each box to contain 3 complete rounds less than has been proposed. This would still give 24 rounds per box, or 48 rounds per limber, or 12 more per gun than at present. The total number of rounds in a subdivision, with a gun limber and two other similar limbers (including the 4 rounds in the axletree boxes) would then be 148, or the same number of rounds as are now carried in a subdivision of the 9-pr. service equipment. By such a modification of the limber proposal it is believed that a saving of about $\frac{3}{4}$ cwt. could be made in the total weight of the experimental limber, packed complete, owing to the elimination of the 6 rounds of ammunition, and the consequent smaller size of the 2 limber boxes, which could then be made much shallower. These boxes having been made in 1876, great improvements could naturally now be made, both as to their construction and in the materials used. The experimental limbers would then weigh only about $1\frac{1}{4}$ cwt. more than the service limbers when completely packed, but they would have 12 more rounds with them. Two experimental limbers would weigh $5\frac{1}{2}$ cwt. less than a service wagon, while conveying 12 rounds less. The total number of rounds, however, in a subdivision would be the same on either plan, while the superior mobility and perfect interchangeability of the limber system will be patent to everyone. For active service in Afghanistan or in Central Asia the limbers would be found very handy. A limber system would, in fact, give us a light artillery possessed of much mobility, besides other advantages, not the least of which would be the very much smaller number of horses that would be necessary as compared to the requirements of horse artillery. Not only would this be a direct saving, which might be applied to putting more guns in the field, but in operations in sterile or barren countries, or beyond sea, and far from our base, the strain on the commissariat and transport departments would be very considerably diminished.

Modification of original proposal.

Limber system advantageous for service in distant and sterile countries.

Comparison of number of guns turned out and rounds fired on proposed and present systems.

Further, there would appear to be some very important advantages connected with a limber system over and above those that have been already enumerated. A gun and limber of the 9-pr. service equipment of field artillery have 6 horses, and an ammunition wagon would also require 6 horses in the field, making 12 in all. There would be with this gun and wagon a total of 148 rounds of ammunition. After modifying the limber system as proposed, we should require 6 horses for the gun and limber, and 4 more horses in the field for the first line of limbers closely accompanying the gun, or 10 horses for the 2 carriages. These would convey a total of 100 rounds per gun. Now, 400 guns on such a limber system would thus take up 4000 horses. whereas only 333 guns on the wagon system could be turned out with the same number of horses. If we then imagine 400 guns on the above plan to be pitted against 333 guns on the wagon system for 50 minutes in action, and each set of guns to fire at the rate of 2 rounds per minute with equal accuracy, the result would be that the force possessing the 400 guns would have fired 40,000 rounds, while that with only 333 guns will have fired only 33,300 rounds, showing a difference of 6700 more shells discharged by the 400 guns on a limber system in the 50 minutes; or even were this cannonade to occupy a whole hour, the comparison would remain the same. It is true that the 333 guns would at the end of that time still have 48 rounds per gun remaining, if their ammunition wagons were intact, whereas the 400 guns would have fired their last round, should no call have been made on the reserves; but may it not be assumed that the very great preponderance of fire (namely, 6 shots to every 5) kept up by the 400 guns should have so materially damaged the more exposed wagon system, both in men and horses, as well as in equipment, as to have virtually settled the affair in favour of the guns on the limber system? And further, may not 100 rounds per gun be considered sufficient for a body of field artillery to have at its immediate disposal during an engagement, when this complement could be constantly kept up and replenished from the reserve ammunition columns of a force in the field? If we pursue the above comparison, but take on the one hand the number of horses necessary on a limber system for a gun and limber with another limber following, and for the 3 mounted men proposed for each piece, and on the other hand the number of horses required by a gun and limber and an ammunition wagon, together with a mounted detachment of 8 men of horse artillery; we could have 400 guns on the limber plan, with 5200 horses, but these could only horse 260 guns of horse artillery. A duel of 1 hour between 400 guns and 260 guns would enable the side with the 400 to fire 14,000 more shells than the other, or 4 shots to every 3, and the result would be obvious.

Proposed limbers equally applicable to heavier field guns.

Trials would cost nothing.

It will be evident, also, to those acquainted with the subject that the principles of a limber system could be applied to any calibre of field gun; in fact, the heavier the ammunition becomes, the more advantageous would it appear to be to replace the lumbering and cumbrous wagons by a system of light and interchangeable limbers; and in these days of large outlays of public money on experiments in heavy ordnance, it may be that it would not be amiss thoroughly to test the

experimental limber in England, as it would not cost Government a single sixpence to do so.

We have seen that the slight enlargement of the boxes of the limber, together with the weight of the 12 extra rounds carried, would give possibly an additional 1½ cwt. or 12 stone to the weight of the service limber packed complete. This would, however, be in the limber itself; that is, close to the horses. Now, an average gunner weighs about 12 stone or 1½ cwt. Three gunners are often carried, according to the present system, on the gun limber, and 2 more on the axletree seats; that is, far away from the point of draught. With the limber system it is proposed to carry only 2 gunners on the limber, and none on the axletree seats; that is, 3 gunners less would be on the gun and carriage than at present. But the weight of 1 gunner, as above shown, would be added by the limber system in extra ammunition, &c.; therefore there would remain only the weight of 2 gunners to the advantage of that plan, or a matter of 3 cwt. off the tail of the load. There would be besides the tangible gain of having 12 more rounds with every gun when working by itself in action, and also 2 horses as well as 1 driver in every subdivision could be dispensed with.

Comparison of weights of gunners and rounds proposed to be carried, and present system.

We make 4 horses draw an ammunition wagon in England on a peace footing, even with many gunners on it, and, as this carriage is much heavier than the gun, obviously 4 horses might be made to suffice for the latter also during peace. Thus it would appear to be quite feasible in times of peace to work with a gun team of only 4 horses, and 2 horses to the extra limber; which, with 3 mounted men accompanying each gun, as proposed, would give 9 horses per subdivision. The wagon system on a peace footing takes 11 horses for the gun and wagon and 1 mounted man.

Comparison of the numbers of horses on peace footing of present and proposed systems.

Again, if we compare the wagon alone with the proposed limber, both on a peace footing, it is plain that only one-half the number of horses and drivers would be wanted by the line of extra limbers that are now used by a line of wagons on a peace establishment; and in the field the wagon has often been made a perfect *omnium gatherum* requiring many horses.

Were poles to be adopted instead of shafts, then a perfectly uniform and interchangeable equipment of saddlery and harness could be introduced, giving the advantages of simplicity, lightness, and cheapness, together with the thorough adaptability of any horse and its equipments at any moment to any place in the battery—a most important advantage on service. This principle of general adaptability should, indeed, be thoroughly carried out with the men, as well as with the horses and equipments, by a complete similarity of training all round in the field artillery. Horses suitable for artillery purposes are in daily use in civil life, and these are very generally found trained to work in double harness and pole draught—as, for instance, those used in vans, omnibuses, &c. This is important with regard to the possibility of sudden expansion to a war footing, and the consequent heavier demand for trained horses. With pole draught an additional gunner could ride on the off wheel horse, whenever rapid movement of the battery became necessary; and should it at any time—in peace manœuvres,

Some advantages of pole draught, and of proposed plan in the field.

for instance—be found that extra draught power was required, then 2 of the 3 mounted men with each gun could readily hook in their horses as leaders until the difficulty were surmounted. In the above manner, great economy of horses and drivers could go hand-in-hand with the up-keep of a large number of guns on a plan of considerable efficiency, which would further be capable of rapid expansion to a war footing when required.

Experience has proved that the difficulty of making gun horses stand fire is almost nominal, and further that it takes less time and trouble to accustom horses to pole than to shaft draught. In the field a horse artillery gun and detachment (including drivers) would comprise 13 men and 14 horses; a field battery gun (2 mounted men included) would have 10 men and 8 horses; a gun on the proposed plan (including 3 mounted men) would have 11 men and 9 horses. This is leaving out wagons or extra limbers. Suppose each gun on these several footings to lose 3 men and 3 horses in action. Then the horse artillery gun would still have 10 men and 11 horses, and be efficient; the field battery gun would still have 7 men and 5 horses, but its mobility would be destroyed; the gun on the limber system would have 8 men and 6 horses, and retain greater mobility than the old Bengal Horse Artillery, and this latter plan would only then take up 6 horses per gun to 11 still required for every gun of horse artillery!

500 guns could be horsed instead of 400.

It has often occurred that, in a fit of economy, a number of field batteries have been either reduced or transformed into garrison artillery —presumably on account of the expense of keeping up the horses; and then we have as frequently been driven to remount those batteries for the field in hot haste, and at war prices, in one of our periodical panics. This can hardly be considered either good economy or becoming the dignity of a great nation. It is obvious that if we simply have a two-horse limber following a field gun in time of peace instead of a four-horse wagon, there would be 1 driver and 2 horses less required for each piece. Now the gun and its wagon takes 10 draught horses, and a limber system would require 2 less: that is, 2 horses in every 10 could be reduced. One driver less out of every 5 would also suffice. Therefore four-fifths of the present number of drivers and horses would turn out the same number of guns, or the same number of horses and drivers would put one-fifth more guns on parade, or 500 guns for the present cost of 400. True, the limbers would carry only 48 rounds each, while the wagon holds 108 rounds; but the gun and its limber together with 1 extra limber would carry in all 100 rounds, or more than sufficient on a peace footing.

Proposed conversion of material gradual and economical.

Very nearly all the present artillery material could be utilised if the change were carried out, as the modifications proposed are almost entirely confined to the boxes containing the ammunition; and the conversion of the wagon equipment into a limber system would only necessitate a reconstruction of the boxes on the carriages with some minor details of fittings, and an alteration of some wagon body frames, in order to carry a spare wheel in rear as well as in front. There need

be no waste of material, for the change could be effected by degrees, as the present equipments became unserviceable, according to custom in such cases; and even such component parts of the wagon equipment (as, for instance, wagon body perches) that would not enter into the general working of the proposed plan (except for spare wheel carriages) could be used up in turn with such wagon equipments as were still on charge, or with reserve ammunition columns.

Increasing importance of light artillery.

After the above simple statements, does it require any very great mathematical mind to grasp the facts that a limber system would be a positive economy and a great advantage in the end, and that the cost of its introduction need scarcely, indeed, be felt? The time may yet arrive when the possession of a considerable force of uniformly light and handy field artillery will be considered to be of supreme importance; and the steps taken in this direction on the Continent of Europe prove the increasing prominence that is given there to this arm of the service. At the present time it would seem that our field artillery equipments are not in all respects in keeping with the general military progress of the age; and however well the heavy ammunition wagon may have served us in days gone by, it may fairly be questioned whether it had not better have been buried at the same time as many a fine old soldier, or other memento of contemporary origin. We have outlived the days of wooden naves, sugar-tong seats in the saddle, pedlar-like packs, leather stocks, and brown besses, and may yet hope to see the last of the lumbering and antiquated ammunition wagons, as also of muzzle-loaders either large or small.

Light artillery, far from being of less avail than formerly, only requires a really progressive development and thoroughly good handling. A far greater use might also be made of light mortars in the field; and Gatlings should be worked with and by infantry. The clumsy use made of the Russian artillery at Plevna has not prevented the recent large increase of that arm in continental armies, and we can wish for nothing better than the chance of proving what different results might be obtained by a vigorous handling of a numerous and mobile British artillery in the field, organised so as to possess a maximum number of guns with a minimum number of men and horses to keep up or to be exposed to fire, and having in each limber 12 more rounds than at present, while the ammunition supply would be more rapid and less risky in action, by reason of its better distribution. All the above advantages could be secured by the adoption of a limber system of equipment, which might, indeed, give quite a fresh impetus to the tactical action and working of the entire body of our light artillery. Shall we, then, wait to see whether other nations will make the change before us?

NOTE ON THE AMMUNITION EQUIPMENT OF ARTILLERY IN THE FIELD.

BY

COLONEL W. J. WILLIAMS, R.A., C.B.

THE ammunition equipment is 4 rounds of case a gun for close quarters, 32 rounds of common shell for heavy and rough work, and 112 rounds of shrapnel to fire upon the enemy in the open, or comparatively in the open, and when time fuzes can be adapted to the range. Sending into the field batteries mainly equipped with shrapnel is an experiment. However much we may appear to be justified by the possession of a time fuze which is good enough in England, and by our observation of shrapnel fire on practice ranges, it would yet seem that we have entered upon our experiment without sufficiently considering the conditions of service in the field.

The main point which has been overlooked, or not sufficiently considered, is that a battery in battle will not use time fuzes like a battery on a practice range. When fire is passing through a battery, or over it, the simplest service of the guns is the best: the conditions are unfavourable to the adaptation of time fuzes. Moreover, an officer cannot always be going out to the position of a range party, to see if the practice is good; and, with time fuzes, the practice cannot be at all judged from anywhere near the guns. Other important points apparently overlooked, or not sufficiently considered, are the uselessness of shrapnel fire against any heavy cover, and the danger of firing with time fuzes over our own people, or across their front, when they are near the enemy; that is to say, when the support of artillery fire would avail them most.

It is not denied that effective shrapnel fire is more powerful than the effective fire of common shell with percussion fuzes. It may, however, be affirmed that the more rough and ready ammunition is always reliable in battle, and that the more delicate ammunition may too often be fired away like blank cartridge, so far as the people aimed at are concerned. Considering, then, the relative value in battle of the two kinds of shell, and, further, the necessity which may at any time arise for guns to defend their own immediate front, it would appear that 8 rounds of case, 32 rounds of common shell, and 108 rounds of shrapnel, would be a better equipment than that which is now carried. Much would, undoubtedly, be gained by the adoption of the equipment submitted; but it would then remain a question whether it would not be better to increase the proportion of common shell.

5th December, 1879.

ON THE ROTATION REQUIRED FOR THE STABILITY OF AN ELONGATED PROJECTILE.

(AN ELEMENTARY DEMONSTRATION.)

BY

A. G. GREENHILL, M.A.

(*Professor of Mathematics to the Advanced Class of Artillery Officers.*)

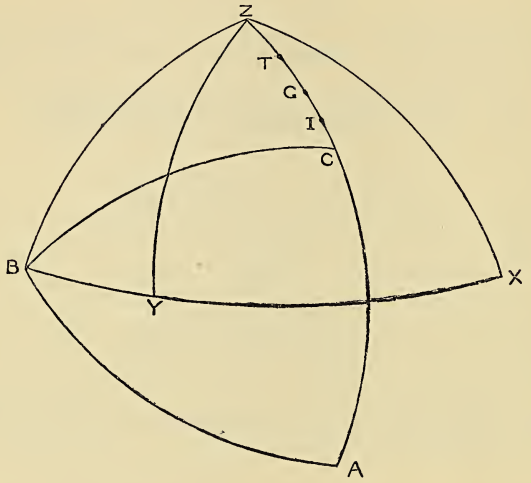
When a body moves in a medium it sets the medium in motion, and the inertia of the body—that is, its resistance to change of motion—is no longer necessarily the same in all directions, as it would be in a vacuum.

Consider an elongated projectile of revolution moving in air under no forces, and let c_1 denote the inertia of the body to motion perpendicular to its principal axis, c_3 the inertia of the body to motion in the direction of that axis; then if u, w be the component velocities perpendicular to and in the direction of the axis, c_1u and c_3w will be the components of linear momentum in those directions respectively; and if no forces act on the body, c_1u and c_3w will have a resultant, Z suppose, fixed in magnitude and direction, by the principle of the conservation of linear momentum.

If O be the centre of the body, and if p be the component angular velocity about an axis OA, perpendicular to the axis of figure, then this motion of the body will stir up the surrounding medium; and if c_4p be the component angular momentum about OA of the body and medium, then c_4 is called the effective moment of inertia of the body about an equatoreal axis.

If r be the component angular velocity about the axis OC of figure, then, since this angular velocity will not stir up the surrounding medium, the body being supposed to be a smooth solid of revolution, c_6r will be the component angular momentum about OC, c_6 being the moment of inertia of the body about OC; r will remain constant during the motion, the body being smooth and the medium frictionless.

Describe a sphere of unit radius with centre O, and let OZ be the direction of the resultant linear momentum Z, OG of the resultant



angular momentum G of the system, OC of the axis of figure. (In the figure the eye is supposed to be at O, and looking at the concave side of the sphere—just as the eye sees the concave side of the celestial sphere.) The angular velocities p and r are estimated on the right-handed screw system (that is, an angular velocity r about OC is reckoned positive when on a right-handed screw it would cause a transference from O to C).

If the centre, O, of the body had been fixed, then OG, the axis of resultant angular momentum, would have been fixed, and the body would have behaved as if the equatoreal and polar moments of inertia were c_4 and c_6; the axis OC would have described a right circular cone about OG as axis; and the motion might have been represented by rolling the right circular cone of axis OC and semi-vertical angle IOC, fixed in the body, on the right circular cone of axis OG and semi-vertical angle IOG, fixed in space; OI being the instantaneous axis of rotation, and therefore

$$\tan IOC = \frac{c_6}{c_4} \tan GOC.$$

But when the body moves steadily in the medium under no forces, O describes a uniform helix about a fixed straight line parallel to OZ, while OG, OI, and OC lie in a plane passing through OZ, which revolves with uniform angular velocity (μ suppose), while OC makes a constant angle (α suppose) with OZ, and OG makes a constant angle (θ suppose) with OC.

Then, if OA be the equatoreal axis in the plane ZOC,

$$c_1 u = \text{component momentum in the direction } OA$$
$$= Z \cos ZOA = -Z \sin \alpha,$$
$$c_3 w = \text{component momentum in the direction } OC$$
$$= Z \cos ZOC = Z \cos A;$$

and therefore, if OT be the direction of motion of O, the tangent to the helical path described by O,

$$\tan COT = -\frac{u}{w} = \frac{c_3}{c_1} \tan \alpha.$$

In consequence of the direction of motion OT not being in the direction of the axis OC, the body will experience a couple about the axis OB, perpendicular to the plane AOC, of magnitude.

$$(c_3 - c_1) uw = \frac{c_3}{c_1} (c_1 - c_3) w^2 \tan \alpha.*$$

Since the rate of change of angular momentum is equal to the impressed couple, therefore

$$G\mu \sin (\alpha - \theta) = \frac{c_3}{c_1} (c_1 - c_3) w^2 \tan \alpha. \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

But $G \cos \theta = \text{component angular momentum about } OC = c_6 r,$

$-G \sin \theta =$ " " " " $OA = c_4 p;$

and $p = -\mu \sin \alpha,$

since the velocity of C, considered as due to the angular velocity about OA is p, and due to the angular velocity about OZ is $\mu \sin \alpha$, and these are in opposite directions.

Therefore $$G \sin \theta = c_4 \mu \sin \alpha,$$

and $$\tan \theta = \frac{c_4 \mu}{c_6 r} \sin \alpha.$$

But, from (1),

$$G\mu \sin (\alpha - \theta) = c_6 r \mu \frac{\sin (\alpha - \theta)}{\cos \theta}$$
$$= c_6 r \mu (\sin \alpha - \cos \alpha \tan \theta)$$
$$= c_6 r \mu \sin \alpha - c_4 \mu^2 \sin \alpha \cos \alpha$$
$$= \frac{c_3}{c_1} (c_1 - c_3) w^2 \tan \alpha;$$

---

* Thomson and Tait, "Natural Philosophy," sec. 324, new edition.

and dropping the fraction sin α, which equalled to zero would imply perfect centering,

$$c_6 r\mu - c_4\mu^2 \cos\alpha = \frac{c_3}{c_1}(c_1 - c_3)\frac{w^2}{\cos\alpha},$$

$$\text{or } c_4 \cos\alpha\mu^2 - c_6 r\mu + \frac{c_3}{c_1}(c_1 - c_3)\frac{w^2}{\cos\alpha} = 0; \quad \ldots\ldots\ldots\ldots\ldots(2)$$

a quadratic equation in μ.

Solving this quadratic,

$$\mu = \frac{c_6 r \pm \sqrt{\left\{c_6^2 r^2 - 4\frac{c_3}{c_1}(c_1 - c_3)\, c_4 w^2\right\}}}{2c_4 \cos\alpha},$$

and therefore the least admissible value of r, in order that the roots of this quadratic should not be imaginary, is given by

$$c_6^2 r^2 = 4\frac{c_3}{c_1}(c_1 - c_3)\, c_4 w^2,$$

$$\text{or } \frac{r^2}{w^2} = 4\frac{c_3}{c_1}(c_1 - c_3)\frac{c_4}{c_6^2}.$$

If the shot had been fired from a gun of calibre $2a$, the rifling at the muzzle making one turn in n calibres, and β being the angle of rifling at the muzzle, then

$$\tan\beta = \frac{\pi}{n} = \frac{ar}{w} = 2a\sqrt{\frac{c_3}{c_1}(c_1 - c_3)\frac{c_4}{c_6^2}}. \quad \ldots\ldots\ldots\ldots\ldots(3)$$

If W = weight of shot,

W' = weight of air displaced,

then

$$c_1 = W + W'\alpha,$$
$$c_3 = W + W'\gamma,$$
$$c_4 = Wk_1^2 + W'k'_1{}^2\alpha',$$
$$c_6 = Wk^2;$$

where k_1, k are the radii of gyration of the shot about OA and OC, and k'_1 of the air displaced (supposed rigid) about OA; α, γ, α' being certain quantities depending only upon the external shape of the body.

The only body for which α, γ, and α' have been, as yet, determined by mathematicians is the ellipsoid, the surrounding medium being

supposed frictionless and incompressible; and for the particular case of the prolate spheroid of semi-axes a and c,

$$\left.\begin{aligned} \alpha &= \frac{A}{A+C}, \quad \gamma = \frac{C}{2A}, \\ \text{and} \quad \alpha' &= \frac{A-C}{\dfrac{c^2-a^2}{c^2+a^2}(2A+C) - A + C} \left(\frac{c^2-a^2}{c^2+a^2}\right)^2; \end{aligned}\right\} \quad ..(4)$$

where

$$A = \int_0^\infty \frac{d\lambda}{(a^2+\lambda)^2 (c^2+\lambda)^{\frac{1}{2}}} = \frac{c}{a^2(c^2-a^2)} - \frac{1}{2(c^2-a^2)^{\frac{3}{2}}} \log_\epsilon \frac{c+\sqrt{c^2-a^2}}{c-\sqrt{c^2-a^2}},$$

$$C = \int_0^\infty \frac{d\lambda}{(a^2+\lambda)(c^2+\lambda)^{\frac{3}{2}}} = \frac{1}{(c^2-a^2)^{\frac{3}{2}}} \log_\epsilon \frac{c+\sqrt{c^2-a^2}}{c-\sqrt{c^2-a^2}} - \frac{2}{c(c^2-a^2)}.*$$

Where, as in practice, the fraction $\frac{W'}{W}$ is so small that its square may be neglected, we have

$$\begin{aligned} \tan^2\beta = \frac{\pi^2}{n^2} &= 4\frac{c_3}{c_1}(c_1 - c_3)\frac{a^2 c_4}{c_6^2} \\ &= 4\frac{W+W'\gamma}{W+W'\alpha} \cdot W'(\alpha-\gamma)a^2 \frac{Wk_1^2 + W'k'_1{}^2\alpha'}{W^2k^4} \\ &= 4\frac{1+\frac{W'}{W}\gamma}{1+\frac{W'}{W}\alpha} \cdot \frac{W'}{W}(\alpha-\gamma)a^2 \frac{k_1^2 + \frac{W'}{W}k'_1{}^2\alpha'}{k^4} \cdot \\ &= 4\frac{W'}{W}(\alpha-\gamma)\frac{a^2k_1^2}{k^4} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5) \end{aligned}$$

+ higher powers of $\frac{W'}{W}$, which are neglected.

From equations (4) and (5) Captain J. P. Cundill, R.A., has calculated a table of values of $\alpha - \gamma$ and the corresponding value of n for service projectiles, and the results obtained appear to agree very fairly with what is observed in practice.

It may be noticed from the formula that, on the hypothesis of the incompressibility of the medium, the value of n is independent of (1) the velocity, (2) the calibre, or length of bore; so that, for similar projectiles, one value of n would do for all guns in the service.

When, however, the velocity is high and the projectile is large, the compression of the air cannot be neglected, and the air behaves as if its density were increased; so that less rotation is required than that given by the formula.

For instance, the 80 and 100-ton guns are rifled at the muzzle with a twist of one turn in 50 calibres, while the formula would give one turn in 40 calibres as requisite for common shell three calibres long.

---

* "Quarterly Journal of Mathematics," Vol. XVI. "Mathematical Papers of the late George Green," edited by the Rev. N. B. Ferrers, p. 322.

ON THE DERIVATION, OR DRIFT, OF ELONGATED RIFLED PROJECTILES.

BY

A. G. GREENHILL, M.A.

(*Professor of Mathematics to the Advanced Class of Artillery Officers.*)

The principles of the preceding paper afford an explanation of the drift of an elongated projectile to the right of the plane of fire.

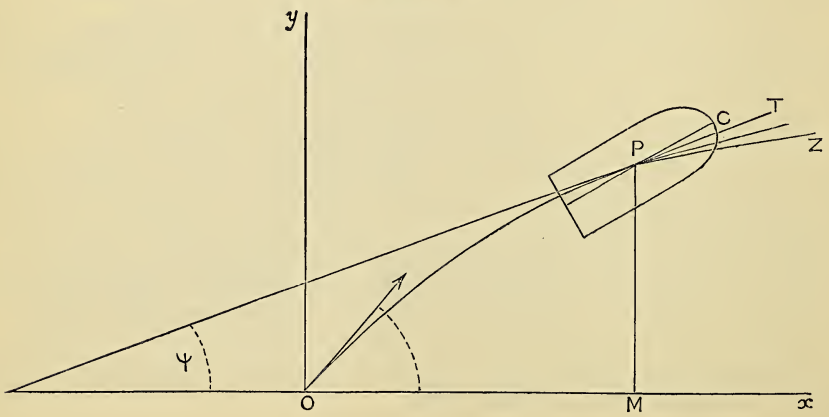
If a projectile were fired in a vacuum, the axis would remain parallel to itself during the trajectory; no rifling would be required, and there would be no drift.

But it is observed that a projectile fired in air, with proper spin, has its axis in the tangent to the trajectory (very nearly), and that after it has reached a distance, short in comparison to ordinary ranges, from the muzzle, all "wabbling" ceases, being destroyed by the friction of the air, and the shot may be said, like a top, to "go to sleep."

Closer observation reveals that the point of the shot is a little above and to the right of the exact tangent to the trajectory; this deviation becoming more marked at the end of the trajectory.

A shot, even if perfectly centred, on issuing from the muzzle, has after the first instant its axis inclined to the tangent to the trajectory, in consequence of the curvature of the path of the centre of gravity due to the action of gravity.

ELEVATION.



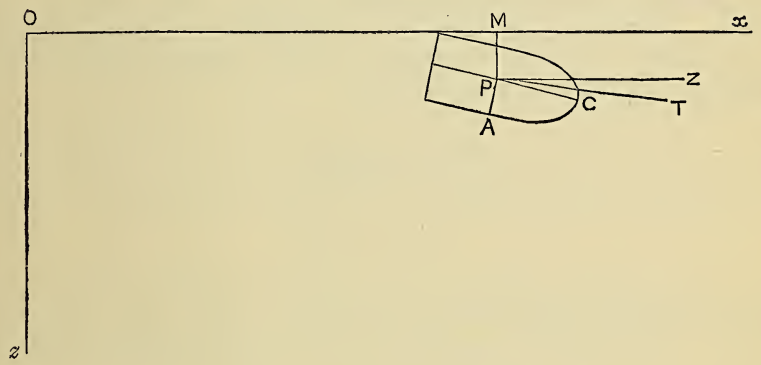
Take O, the origin, at the muzzle of the gun, Ox horizontal in the vertical plane of departure, Oy vertical, and Oz horizontal to the right of the plane of fire.

Let P be the centre of gravity of the shot; x, y, z the co-ordinates of P; PC the axis of the shot; and PT the tangent to the path of P.

If there were no air, then PC would remain parallel to the tangent of the curve OP at O.

But the air causes a couple to act on the shot, tending to set the axis of the shot across the direction of motion; and this couple, acting on the shot (supposed to have angular momentum $c_6 r$) about PC, will deflect the axis PC to the right; and after a few gyrations, which are destroyed by the friction of the air, the shot will move steadily, with its point permanently deflected slightly to the right.

PLAN.



PZ (the direction of the resultant momentum Z of the body and the medium) will remain constantly parallel to the plane xOy, because there is no impressed force perpendicular to this plane; and if α be the angle the axis of the shot makes with the plane xOy, and if u, w be the component velocities of P along PA and PC, then, as before,

$$c_1 u = -Z \sin \alpha,$$

$$c_3 w = Z \cos \alpha,$$

and therefore the velocity of P in the direction Oz,

$$\frac{dz}{dt} = u \cos \alpha + w \sin \alpha$$

$$= Z\left(\frac{1}{c_3} - \frac{1}{c_1}\right) \sin \alpha \cos \alpha.$$

Now, the couple acting on the body in the plane APC is

$$(c_1 - c_3)\, uw = Z^2 \left(\frac{1}{c_3} - \frac{1}{c_1}\right) \sin \alpha \cos \alpha;$$

and this, acting on the resultant angular momentum of the shot (which may be taken to be $c_6 r$, and indifferently about the axis PC or PT, since they are very nearly coincident), will cause the point of the shot C to descend so as always to be very nearly in the tangent to the trajectory; and therefore if the tangent at P makes an angle ψ with the horizon,

$$-c_6 r \frac{d\psi}{dt} = Z^2 \left(\frac{1}{c_3} - \frac{1}{c_1}\right) \sin \alpha \cos \alpha = Z \frac{dz}{dt},$$

$$\text{or } \frac{dz}{dt} = -\frac{c_6 r}{Z} \frac{d\psi}{dt};$$

the negative sign being taken with $\frac{d\psi}{dt}$, because ψ is diminishing.

The resultant momentum Z may be put equal to Wv; where v is the resultant velocity in the trajectory, neglecting the momentum due to the motion of the air, which is small compared with Wv, the momentum of the shot; and therefore

$$\frac{dz}{dt} = -\frac{c_6 r}{Wv} \frac{d\psi}{dt}$$

$$= -k^2 \frac{r}{v} \frac{d\psi}{dt}.$$

If the angular velocity r died away at the same rate as the linear velocity v, the fraction $\frac{r}{v}$ would be constant, and equal to the value it has at the muzzle—namely, $\frac{\pi}{na}$; $2a$ being the calibre.

Then $$\frac{dz}{dt} = -\frac{\pi}{n} \cdot \frac{k^2}{a} \cdot \frac{d\psi}{dt},$$

and $$z = \frac{\pi}{n} \frac{k^2}{a} (\phi - \psi),$$

if ϕ is the circular measure of the angle of projection.

On this assumption the drift would be proportional to the change of direction of the motion, and the total drift to the sum of the angles of ascent and descent.

Using u now to denote the horizontal component of the velocity,

$$\frac{dz}{du} = -\frac{\pi}{n} \frac{k^2}{a} \frac{d\psi}{du}$$

$$= -\frac{\pi}{n} \frac{k^2}{a} g \frac{w}{d^2} \frac{(1000)^3}{Kv^4}.$$

For resolving horizontally and normally,

$$\frac{du}{dt} = -\frac{d^2}{w} K \left(\frac{v}{1000}\right)^3 \cos\psi,$$

$$v\frac{d\psi}{dt} = -g\cos\psi;$$

and dividing one equation by the other,

$$\frac{d\psi}{du} = g\,\frac{w}{d^2}\,\frac{(1000)^3}{Kv^4}.$$

In ordinary flat trajectories we may replace u by v, and then

$$\frac{d^2}{w}z = \frac{\pi}{n}\frac{k^2}{a}g\int_v^V \frac{(1000)^3}{Kv^4}\,dv,$$

$$= \frac{\pi}{n}\frac{k^2}{a}\frac{\pi}{180}(D_v - D_V). \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

This integral has been calculated by Mr. Niven for velocities from 900 to 1700 f.s., and is given on p. 78 of Major Sladen's "Principles of Gunnery," and he is at present engaged in extending the range of velocities from 400 to 2500, using the values of K lately determined by Mr. Bashforth from the experiments carried out in 1878 and 1879. ("Report on Experiments made with the Bashforth Chronograph, &c.," Part II.)

But it is more usual to assume that the angular velocity r dies away very slowly, so that we may suppose it constant, and equal to the value it has at the muzzle—namely, $\frac{\pi V}{na}$; and then

$$\frac{dz}{dt} = -\frac{\pi}{n}\frac{k^2}{a}\frac{V}{v}\frac{d\psi}{dt},$$

or

$$\frac{dz}{du} = -\frac{\pi}{n}\frac{k^2}{a}Vg\,\frac{w}{d^2}\,\frac{(1000)^3}{Kv^5},$$

and

$$\frac{d^2}{w}z = \frac{\pi}{n}\frac{k^2}{a}Vg\int_v^V \frac{(1000)^3\,dv}{Kv^5}; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

so that we shall require the integral $\int_v^V \frac{(1000)^3}{Kv^5}\,dv$ to be tabulated to calculate the drift.

The drift is proportional to $\frac{w}{d^2}$, which varies very nearly as the calibre, and also to $\frac{k^2}{a}$, which also varies as the calibre for similar projectiles; so that the drift varies as the square of the calibre for the same initial and final velocity. This explains why the drift is insensible in small-arms.

The preceding explanation is substantially the same as that given by Prof. Magnus, except that the consideration of the *centre of effort* is not necessary.

Magnus began by trying to explain the drift as due to the differences of pressure in consequence of the existence of a vortex round the shot; but this would make the shot drift to the *left*.

In the January, 1880, number of the "Messenger of Mathematics" it is shown that a horizontal cylinder of density σ, revolving with angular velocity ω in infinite liquid of density ρ, and surrounded by a vortex, would, if left to itself, describe a cycloid from right to left, with mean velocity $\frac{\sigma - \rho}{2\rho} \frac{g}{\omega}$, and that if projected with this velocity would describe a horizontal straight line.

When a gas-check becomes detached from the base of a shot, the forward motion is soon destroyed, but the angular velocity remains, and the gas-check behaves in a similar manner to the above cylinder, and drifts to the left, with mean velocity $\frac{\sigma - \rho}{2\rho} \frac{g}{\omega}$.

For instance, in the 16-in. 80-ton gun

$$\omega = \frac{\pi}{n} \frac{V}{a} = \frac{\pi}{50} \frac{1600}{\frac{2}{3}} = 48\pi,$$

and for copper, $\sigma = 8{\cdot}6$,

while for air, $\rho = {\cdot}001276$,

therefore $$\frac{\sigma - \rho}{2\rho} \frac{g}{\omega} = 715;$$

the mean velocity with which the gas-check will drift to the left, if it becomes detached from the base of the shell.

It is only in such a case as this, then, that we can assert (as on p. 589, Vol. X., "Proceedings, R.A. Institution") that the drift diminishes as ω the angular velocity increases; and the paradoxical result that the velocity of drift is infinite when the angular velocity is zero, only means that we should require to project the cylinder from right to left with infinite velocity in order that the path should not be curved.

From the preceding explanation we see that the drift is proportional to the angular velocity. This explanation is rendered necessary by the unfortunate mis-statement on p. 589, which was written down hastily, and of which the incorrectness escaped notice till after the paper was printed.

We can gain an approximate idea of the amount of deflection of the point to the right, and above the tangent to the trajectory, by considering them separately, each being supposed small. For if α' denote the angle between the axis of the shot and the vertical plane through the tangent of the trajectory, then

$$\tan \alpha' = \frac{c_3}{c_1} \tan \alpha,$$

and the couple acting on the shot about the axis normal to the trajectory in this vertical plane

$$= (c_1 - c_3)\, v^2 \sin \alpha' \cos \alpha';$$

which must therefore

$$= - c_6 r \frac{d\psi}{dt},$$

and therefore

$$\sin 2\alpha' = - \frac{2c_6 r}{c_1 - c_3} \frac{1}{v^2} \frac{d\psi}{dt}$$

$$= \frac{2c_6 r}{c_1 - c_3} \frac{g \cos \psi}{v^3}.$$

Again, if β' be the angle between the axis of the shot and the plane through the tangent of the trajectory perpendicular to the plane xOy, the couple acting on the shot about the axis PA

$$= (c_1 - c_3)\, v^2 \sin \beta' \cos \beta';$$

and this with our approximations must be put

$$= c_6 r \frac{d\alpha}{dt},$$

and therefore

$$\sin 2\beta' = \frac{2c_6 r}{c_1 - c_3} \frac{d\alpha}{dt}.$$

If the rifling at the muzzle be just sufficient for stability,

$$\frac{2c_6 r}{c_1 - c_3} = 8 \frac{c_3 c_4}{c_1 c_6} \frac{na}{\pi} V$$

$$= 8 \frac{n}{\pi} \frac{k_1^2}{k^2} aV,$$

with the approximations employed; and then

$$\sin 2\alpha' = 8 \frac{n}{\pi} \frac{k_1^2}{k^2} aV \frac{g \cos \psi}{v^3},$$

$$\sin 2\beta' = 8 \frac{n}{\pi} \frac{k_1^2}{k^2} aV \frac{d\alpha}{dt};$$

and with our approximations we may put

$$\frac{d\alpha}{dt} = \frac{d\alpha'}{dt} = \frac{1}{v} \frac{d^2 z}{dt^2}.$$

Table of the Integral $Z = \int_{400}^{v} \frac{(1000)^3\, dv}{Kv^5}$ *for intervals of* 10.

v.	00	10	20	30	40	50	60	70	80	90
	·0000	·0000	·0000	·0000	·0000	·0000	·0000	·0000	·0000	·0000
4	000000	062649	119267	170511	216995	259273	297828	333092	365442	395171
5	422556	447828	471182	492813	512885	531533	548879	565043	580136	594258
6	607494	619908	631560	642504	652794	662474	671583	680158	688241	695871
7	703084	709905	716352	722444	728200	733648	738807	743685	748297	752654
8	756777	760680	764376	767865	771154	774255	777178	779937	782541	785006
9	787337	789537	791620	793593	795461	797234	798916	800512	802027	803467
10	804837	806139	807376	808545	809621	810582	811430	812189	812885	813529
11	814130	814695	815229	815737	816222	816687	817135	817561	817969	818360
12	818735	819095	819440	819771	820089	820395	820689	820972	821245	821507
13	821760	822004	822239	822466	822685	822897	823102	823301	823493	823679
14	823859	824034	824204	824369	824529	824685	824837	824985	825128	825268
15	825404	825537	825667	825793	825917	826038	826156	826272	826384	826494
16	826601	826706	826809	826909	827007	827103	827197	827289	827379	827467
17	827553	827635	827717	827797	827876	827953	828028	828102	828174	828245
18	828314	828382	828448	828513	828577	828640	828701	828761	828820	828878
19	828935	828991	829045	829098	829150	829201	829251	829300	829348	829395
20	829441	829486								

ON THE

MOTION OF A PROJECTILE IN A RESISTING MEDIUM.

BY

A. G. GREENHILL, M.A.

(*Professor of Mathematics to the Advanced Class of Artillery Officers.*)

It is assumed that the resistance of the medium acts through the centre of gravity of the projectile in the tangent to the trajectory, and consequently it follows that the trajectory will lie in a vertical plane.

Resolving normally, supposing v the velocity at the point where the tangent is inclined at an angle ψ to the horizon,

$$v \frac{d\psi}{dt} = -g \cos \psi;$$

the negative sign being required because ψ is diminishing, and therefore $\frac{d\psi}{dt}$ is negative.

If we put $u = v \cos \psi$ (the horizontal component of the velocity), and $p = \tan \psi$, then

$$\frac{d\psi}{dt} = \cos^2 \psi \frac{dp}{dt},$$

and the first equation becomes

$$v \cos^2 \psi \frac{dp}{dt} = -g \cos \psi,$$

or

$$\frac{dt}{dp} = -\frac{u}{g}. \quad \text{.....(1)}$$

Since $\frac{dx}{dt} = u$, therefore multiplying equation (1) gives

$$\frac{dx}{dp} = -\frac{u^2}{g}; \quad \text{.....(2)}$$

and since $\frac{dy}{dx} = p$, therefore

$$\frac{dy}{dp} = -\frac{pu^2}{g}. \quad \text{.....(3)}$$

Suppose the resistance to vary as the n^{th} power of the velocity, then the retardation due to the resistance will be $g\left(\frac{v}{w}\right)^n$; w being the terminal velocity in the medium.

To express u in terms of p, resolve horizontally; therefore

$$\frac{du}{dt} = -g\left(\frac{v}{w}\right)^n \cos\psi;$$

and since

$$\frac{dt}{dp} = -\frac{u}{g},$$

therefore

$$\frac{du}{dp} = \left(\frac{v}{w}\right)^n u\cos\psi$$

$$= \frac{u^{n+1}}{w^n}(\sec\psi)^{n-1};$$

or

$$\frac{w^n}{u^{n+1}}\frac{du}{dp} = (1+p^2)^{\frac{n-1}{2}};$$

Integrating, supposing the velocity is infinite when the trajectory is carried back to the point where the tangent of the inclination to the horizon is a,

$$\left(\frac{w}{u}\right)^n = P,$$

or

$$u = wP^{-\frac{1}{n}}, \quad \ldots\ldots(4)$$

where

$$P = n\int_p^a (1+p^2)^{\frac{n-1}{2}}\,dp. \quad \ldots\ldots(5)$$

and therefore

$$v = w\,(1+p^2)^{\frac{1}{2}}P^{-\frac{1}{n}}.$$

Therefore

$$\frac{dt}{dp} = -\frac{w}{g}P^{-\frac{1}{n}},$$

$$\frac{dx}{dp} = -\frac{w^2}{g}P^{-\frac{2}{n}},$$

$$\frac{dy}{dp} = -\frac{w^2}{g}pP^{-\frac{2}{n}};$$

and carrying the origin back to the point at which the velocity is infinite,

$$t = \frac{w}{g}\int_p^a P^{-\frac{1}{n}}\,dp, \quad \ldots\ldots(6)$$

$$x = \frac{w^2}{g}\int_p^a P^{-\frac{2}{n}}\,dp, \quad \ldots\ldots(7)$$

$$y = \frac{w^2}{g}\int_p^a pP^{-\frac{2}{n}}\,dp. \quad \ldots\ldots(8)$$

Mr. Bashforth puts $n = 3$, and then

$$P = 3\int_p^a (1 + p^2)\, dp$$

$$= 3a + a^3 - 3p - p^3, \quad \text{.....(5)*}$$

$$t = \frac{w}{g}\int_p^a \frac{dp}{(3a + a^3 - 3p - p^3)^{\frac{1}{3}}}, \quad \text{.....(6)*}$$

$$x = \frac{w^2}{g}\int_p^a \frac{dp}{(3a + a^3 - 3p - p^3)^{\frac{2}{3}}}, \quad \text{.....(7)*}$$

$$y = \frac{w^2}{g}\int_p^a \frac{p dp}{(3a + a^3 - 3p - p^3)^{\frac{2}{3}}}. \quad \text{.....(8)*}$$

Here $3a + a^3 = \frac{1}{\gamma}$, $u_0 = w\gamma^{\frac{1}{3}}$; and Mr. Bashforth has calculated by quadratures the values of these integrals for different values of γ, and tabulated them in Tables IV. and VI.

But the substitution $P = (a - p)^3 z^3$ reduces these integrals to elliptic integrals; for, putting $a - p = \frac{1}{q}$, then

$$3\,(1 + a^2)\, q^2 - 3aq + 1 = z^3,$$

and therefore

$$q^2 - \frac{aq}{1+a^2} + \frac{a^2}{4\,(1+a^2)^2} = \frac{z^3 - 1}{3\,(1+a^2)} + \frac{a^2}{4\,(1+a^2)^2} = \frac{z^3 - b^3}{3 + 3a^2},$$

and

$$q = \frac{a}{2 + 2a^2} + \frac{\sqrt{(z^3 - b^3)}}{\sqrt{(3 + 3a^2)}};$$

putting

$$\frac{4 + a^2}{4 + 4a^2} = b^3.$$

Therefore

$$P^{-\frac{2}{3}} dp = \frac{dp}{(a - p)^2 z^2}$$

$$= \frac{dq}{z^2} = \sqrt{\left(\frac{3}{4 + 4a^2}\right)} \frac{dz}{\sqrt{(z^3 - b^3)}},$$

and therefore

$$\frac{gx}{w^2} = \sqrt{\left(\frac{3}{4 + 4a^2}\right)} \int_z^\infty \frac{dz}{\sqrt{(z^3 - b^3)}}; \quad \text{.....(9)}$$

an elliptic integral of the first kind.

Also,

$$\frac{1}{q} = \sqrt{(3 + 3a^2)}\, \frac{\sqrt{(z^3 - b^3)}}{z^3 - 1} - \tfrac{3}{2}\, \frac{a}{z^3 - 1};$$

therefore

$$pP^{-\frac{2}{3}} dp = \left(a - \frac{1}{q}\right) \sqrt{\left(\frac{3}{4 + 4a^2}\right)} \frac{dz}{\sqrt{(z^3 - b^3)}}$$

$$= a\sqrt{\left(\frac{3}{4 + 4a^2}\right)} \left(1 + \tfrac{3}{2}\, \frac{1}{z^3 - 1}\right) \frac{dz}{\sqrt{(z^3 - b^3)}} - \tfrac{3}{2}\, \frac{dz}{z^3 - 1},$$

---

* Bashforth. "Motion of Projectiles," p. 53.

and
$$\frac{gy}{w^2} = a\frac{gx}{w^2} + \tfrac{3}{2}a\sqrt{\left(\frac{3}{4+4a^2}\right)}\int_z^\infty \frac{dz}{(z^3-1)\sqrt{(z^3-b^3)}} - \tfrac{3}{2}\int_z^\infty \frac{dz}{z^3-1}$$
$$= a\frac{gx}{w^2} + \tfrac{3}{2}a\sqrt{\left(\frac{3}{4+4a^2}\right)}\int_z^\infty \frac{dz}{(z^3-1)\sqrt{(z^3-b^3)}} + \tfrac{1}{4}\log\frac{(z-1)^2}{z^2+z+1} - \sqrt{3}\tan^{-1}\frac{2z+1}{\sqrt{3}} + \tfrac{1}{2}\pi\sqrt{3} \quad ...(10);$$

involving elliptic integrals of the third kind.

Again,
$$P^{-\frac{1}{3}}dp = \frac{dp}{(a-p)z} = \frac{dq}{qz}$$
$$= \left\{\sqrt{(3+3a^2)}\,\frac{\sqrt{(z^3-b^3)}}{z^3-1} - \tfrac{3}{2}\frac{a}{z^3-1}\right\}\sqrt{\left(\frac{3}{4+4a^2}\right)}\frac{zdz}{\sqrt{(z^3-b^3)}},$$

therefore
$$\frac{gt}{w} = \tfrac{3}{2}\int_z^\infty \frac{zdz}{z^3-1} - \tfrac{3}{2}a\sqrt{\left(\frac{3}{4+4a^2}\right)}\int_z^\infty \frac{zdz}{(z^3-1)\sqrt{(z^3-b^3)}}$$
$$= \tfrac{1}{2}\pi\sqrt{3} - \tfrac{1}{4}\log\frac{(z-1)^2}{z^2+z+1} - \sqrt{3}\tan^{-1}\frac{2z+1}{\sqrt{3}} - \tfrac{3}{2}a\sqrt{\left(\frac{3}{4+4a^2}\right)}\int_z^\infty \frac{zdz}{(z^3-1)\sqrt{(z^3-b^3)}}; \quad .....(11)$$

also involving elliptic integrals of the third kind.

To reduce equation (9) to the normal form of an elliptic integral of the first kind, put
$$z - b = b\sqrt{3}\,\frac{1+\cos\phi}{1-\cos\phi},$$

and then
$$\int_z^\infty \frac{dz}{(z^3-b^3)} = \frac{1}{\sqrt{(b\sqrt{3})}}\int_0^\phi \frac{d\phi}{\sqrt{(1-k^2\sin^2\phi)}};$$

where
$$k = \frac{\sqrt{3}-1}{2\sqrt{2}} = \sin 15°.$$

Therefore
$$\int_0^\phi \frac{d\phi}{\sqrt{(1-k^2\sin^2\phi)}} = \sqrt{(b\sqrt{3})}\sqrt{\left(\frac{4+4a^2}{3}\right)}\frac{gx}{w^2}$$
$$= \frac{(4+a^2)^{\frac{1}{2}}(4+4a^2)^{\frac{1}{4}}}{3^{\frac{1}{4}}}\frac{gx}{w^2}$$
$$= \mathrm{x}, \text{ suppose};$$

and therefore, with Jacobi's notation,
$$\phi = \mathrm{am}\,(\mathrm{x}, k),$$

and
$$z = b + b\sqrt{3}\,\frac{1+\mathrm{cn\,x}}{1-\mathrm{cn\,x}};$$

denoting $\cos\phi$ or $\cos \operatorname{am} x$ by $\operatorname{cn} x$, $\sin\phi$ by $\operatorname{sn} x$, and $\sqrt{(1-k^2\sin^2\phi)}$ by $\operatorname{dn} x$ for brevity, according to Gudermann's notation.

Suppose $x = a$ when $z = 1$;

therefore
$$\frac{1-b}{b\sqrt{3}} = \frac{1+\operatorname{cn} a}{1-\operatorname{cn} a},$$

and
$$z = \frac{1-\operatorname{cn} a}{1-\operatorname{cn} x}\,\frac{\sqrt{3}+1+(\sqrt{3}-1)\operatorname{cn} x}{\sqrt{3}+1+(\sqrt{3}-1)\operatorname{cn} a}$$
$$= \frac{1-\operatorname{cn} a}{1-\operatorname{cn} x}\,\frac{k'+k\operatorname{cn} x}{k'+k\operatorname{cn} a};$$

since
$$k = \frac{\sqrt{3}-1}{2\sqrt{2}} = \sin 15°,$$

and therefore
$$k' = \frac{\sqrt{3}+1}{2\sqrt{2}} = \cos 15°.$$

Since $\dfrac{\sqrt{3}+1}{\sqrt{3}-1} = \dfrac{k'}{k} = -\operatorname{cn} \tfrac{4}{3}iK'$, we may put

$$z = \frac{1-\operatorname{cn} a}{1-\operatorname{cn} x}\,\frac{\operatorname{cn}\frac{4}{3}iK' - \operatorname{cn} x}{\operatorname{cn}\frac{4}{3}iK' - \operatorname{cn} a};$$

where
$$K' = \int_0^{\frac{1}{2}\pi} \frac{d\phi}{\sqrt{(1-k'^2\sin^2\phi)}}.$$

As a increases from 0 to ∞, b diminishes from 1 to $\dfrac{1}{\sqrt[3]{4}}$, and $\operatorname{cn} a$ increases from -1 to $-\dfrac{\sqrt{3}+1-\sqrt[3]{4}}{\sqrt{3}-1+\sqrt[3]{4}}$, or a diminishes from $2K$ to $\frac{4}{3}K$, where

$$K = \int_0^{\frac{1}{2}\pi} \frac{d\phi}{\sqrt{(1-k^2\sin^2\phi)}},$$

the complete elliptic integral.

Since b is the value of z when $x = 2K$, therefore

$$b = \frac{1-\operatorname{cn} a}{2}\cdot\frac{k'-k}{k'+k\operatorname{cn} a}.$$

Also,
$$z^3 - b^3 = 12\sqrt{3}b^3\,\frac{\operatorname{sn}^2 x\,\operatorname{dn}^2 x}{(1-\operatorname{cn} x)^4}$$
$$= 12\sqrt{3}b^3X^2,$$

putting
$$X = \frac{\operatorname{sn} x\,\operatorname{dn} x}{(1-\operatorname{cn} x)^2};$$

and if B be the value of X when $x = \frac{4}{3}K$, then

$$B = \frac{1}{2\sqrt[4]{3}},$$

and

$$z^3 - b^3 = 3b^3 \frac{X^2}{B^2}.$$

If A be the value of X when $x = a$, then

$$1 - b^3 = 3b^3 \frac{A^2}{B^2};$$

or

$$b^3 = \frac{B^2}{3A^2 + B^2},$$

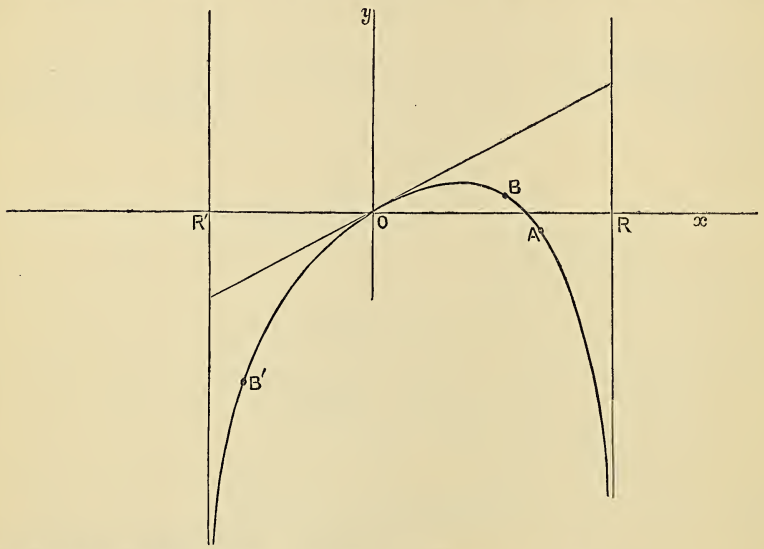
and

$$a^2 = \frac{4 - 4b^3}{4b^3 - 1} = \frac{4A^2}{B^2 - A^2}.$$

When $z = 1$, $p = -\frac{1}{a}$ or ∞; consequently, when $x = a$, the tangent is at right angles to the tangent at the origin, and when $x = 4K - a$, the tangent is the vertical asymptote. Therefore the distance of the vertical asymptote from the origin is

$$\frac{w^2}{g} \frac{3^{\frac{1}{4}}(4K - a)}{(4 + a^2)^{\frac{1}{6}}(4 + 4a^2)^{\frac{1}{3}}}.$$

There will be another vertical asymptote, corresponding to $x = -a$, to the trajectory described when the velocity at the origin is reversed.



(The figure is drawn for $a = \frac{5}{3}K$. A is the point where the tangent is perpendicular to the tangent at the origin, and then $x = \frac{5}{3}K$; B and B' are the points where the velocity is a minimum, and then $x = \pm\frac{4}{3}K$. For OR, $x = \frac{7}{3}K$; for OR', $x = -\frac{5}{3}K$.)

The following table, extracted from Legendre's "Traité des Fonctions Elliptiques," Tom. II., p. 305, Table IX., gives the number of degrees in an angle whose circular measure is ϕ, corresponding to the argument x, the modulus being sin 15° :—

ϕ	x	ϕ	x	ϕ	x
°		°		°	
0	0·00000	31	0·54273	61	1·07566
1	01745	32	56035	62	09358
2	03491	33	57797	63	11151
3	05236	34	59561	64	12945
4	06982	35	61325	65	14740
5	08727	36	63090	66	16536
6	10473	37	64857	67	18333
7	12219	38	66624	68	20130
8	13966	39	68393	69	21928
9	15712	40	70162	70	23727
10	17459	41	71933	71	25527
11	19206	42	73704	72	27328
12	20954	43	75477	73	29127
13	22702	44	77251	74	30930
14	24551	45	79025	75	32733
15	26200	46	80801	76	34535
16	27949	47	82578	77	36339
17	29699	48	84356	78	38143
18	31450	49	86135	79	39947
19	33201	50	87915	80	41752
20	34953	51	89697	81	43557
21	36706	52	91479	82	45362
22	38459	53	93262	83	47168
23	40213	54	95047	84	48974
24	41968	55	96832	85	50781
25	43723	56	98618	86	52587
26	45479	57	1·00406	87	54394
27	47236	58	02194	88	56200
28	48994	59	03984	89	58007
29	50753	60	05774	90	1·59814
30	52513				$= K$

This is all the tabular matter required for the calculation of Mr. Bashforth's X_γ; for

$$\text{cn x} = \frac{z - b - b\sqrt{3}}{z - b + b\sqrt{3}},$$

or

$$\text{x} = \text{cn}^{-1}\frac{z - b\,(\sqrt{3}+1)}{z + b\,(\sqrt{3}-1)},$$

or

$$x = \frac{w^2}{g}\frac{3^{\frac{1}{4}}}{(4+a^2)^{\frac{1}{3}}(4+4a^2)^{\frac{1}{3}}}\,\text{cn}^{-1}\frac{(4+4a^2)^{\frac{1}{3}}P^{\frac{1}{3}} - (\sqrt{3}+1)(4+a^2)^{\frac{1}{3}}(a-p)}{(4+4a^2)^{\frac{1}{3}}P^{\frac{1}{3}} + (\sqrt{3}-1)(4+a^2)^{\frac{1}{3}}(a-p)},$$

giving x in terms of p; and Mr. Bashforth's ${}^{a}X_{\gamma}^{p} = \frac{gx}{w^2}\gamma^{-\frac{2}{3}}$.

Again,

$$\frac{z^3 - b^3}{1 - b^3} = \frac{X^2}{A^2},$$

or

$$z^3 - b^3 = \frac{3a^2}{4 + 4a^2}\,\frac{X^2}{A^2},$$

and therefore
$$q = \frac{a}{2 + 2a^2} + \frac{\sqrt{(z^3 - b^3)}}{\sqrt{(3 + 3a^2)}}$$
$$= \frac{a}{2 + 2a^2}\left(1 + \frac{X}{A}\right)$$
$$= \frac{\sqrt[4]{3}\sqrt{(4 + a^2)}}{1 + a^2}(A + X);$$

since
$$A^2 = \frac{1 - b^3}{12b^3\sqrt{3}} = \frac{a^2}{4\sqrt{3}(4 + a^2)},$$

Therefore
$$p = a - \frac{1 + a^2}{\sqrt[4]{3}\sqrt{(4 + a^2)}} \frac{1}{A + X}$$

giving p in terms of x.

Integrating this equation,
$$y = ax - \frac{1 + a^2}{\sqrt[4]{3}\sqrt{(4 + a^2)}} \int_0^x \frac{dx}{A + X}$$
$$= ax - \frac{w^2}{4gb^2} \int_0^{\mathrm{x}} \frac{d\mathrm{x}}{A + X};$$

an elliptic integral of the third kind, giving y in terms of x.

If, however, $a = 0$, then $b = 1$, $\mathrm{a} = 2K$, and $A = 0$; and
$$\frac{gy}{w^2} = -\tfrac{1}{4}\int_0^{\mathrm{x}} \frac{(1 - \mathrm{cn\ x})^2}{\mathrm{sn\ x\ dn\ x}}\, d\mathrm{x}$$
$$= -\tfrac{1}{4}\int_0^{\mathrm{x}} \frac{1 - \mathrm{cn\ x}}{(1 + \mathrm{cn\ x})(k'^2 + k^2\,\mathrm{cn}^2\,\mathrm{x})}\,\mathrm{sn\ x\ dn\ x}\ d\mathrm{x}$$
$$= \tfrac{1}{4}\int_1^z \frac{1 - z}{(1 + z)(k'^2 + k^2z^2)}\, dz,$$

putting $\mathrm{cn\ x} = z$; and performing the integration,
$$\frac{gy}{w^2} = \tfrac{1}{2}\log\frac{1 + z}{2} - \tfrac{1}{4}\log(k'^2 + k^2z^2) + \frac{1 - 2k'^2}{4kk'}\tan^{-1}\frac{k}{k'}z + C$$
$$= \tfrac{1}{2}\log\frac{1 + \mathrm{cn\ x}}{2\mathrm{dn\ x}} - \frac{\sqrt{3}}{2}\tan^{-1}\left(\frac{\sqrt{3} - 1}{\sqrt{3} + 1}\,\mathrm{cn\ x}\right) + \frac{\pi\sqrt{3}}{24};$$

where $\mathrm{x} = \tfrac{1}{2}\sqrt[4]{3}\,\frac{gx}{w^2}$, $k = \sin 15°$, is the equation of the trajectory when the projectile is fired horizontally with infinite velocity, the resistance varying as the cube of the velocity, and the terminal velocity being w.

The horizontal component of the velocity

$$u = w\frac{q}{z} = w\sqrt[4]{3}\,\frac{\sqrt{(4+a^2)}}{1+a^2}\,\frac{1-\operatorname{cn} x}{1-\operatorname{cn} a}\,\frac{k'+k\operatorname{cn} a}{k'+k\operatorname{cn} x}\,(A+X).$$

The velocity v in the trajectory is a minimum when $\frac{dv}{dp} = 0$, which leads to the equation

$$1 + p\,(3a + a^3) - p^2 = 0,$$

or
$$q^2\,(1+a^2)^2 - aq\,(1+a^2) + 1 = 0,$$

and therefore
$$q = \frac{a \pm \sqrt{(a^2+4)}}{2+2a^2}.$$

Therefore
$$X = \pm\frac{1}{2\sqrt[4]{3}} = \pm B,$$

and
$$x = \pm\tfrac{4}{3}K,$$

at the points of minimum velocity, and at these points the tangents are at right angles.

THE ARMAMENT OF SHERE ALI'S ARMY.

(*Extracted from an Indian Newspaper.*)

COMMUNICATED BY

LT.-COL. SIDNEY PARRY, R.H.A.

Afghanistan is a nation of soldiers, every adult being (apart from any military training he may receive) a ready swordsman and a fair shot. In our old wars we found but little organisation existing among the followers of the Dost and his son, Mahomed Akhbar, and the discipline of our troops told in the long run against the masses they had to face. Afghanistan then produced, as a writer has said, nothing but stones and men: the stones made good *sungars*, and thousands of men were always ready to defend them. But after Shere Ali had assumed the Ameership, a change came over the "war department" of the country: that shrewd sovereign had his eyes opened to the necessity for having something more than an unlimited supply of men to fight his battles, and after his visit to India, in 1869, he began to cast about for means whereby he could arm and equip his troops in civilised fashion. Fortunately for his project, he was on the best of terms at that time with the Indian Government, and among the valuable presents he carried back with him to Cabul were a siege-train (consisting of four 18-prs. and two 8-in. howitzers), a mountain battery of six guns, 5,000 Snider rifles, 15,000 Enfields, and no less than 1,000,000 rounds of ball ammunition. This was the ground-work upon which he hoped to build up a well-equipped army, with artillery sufficient to make himself feared by all his neighbours, and respected both by the English and Russian Governments, upon his relations with which might ultimately depend the safety of his kingdom. To a man of less energy than Shere Ali the project he took in hand would have seemed so full of difficulties that it might have been reasonably abandoned after a fair trial; but the then Ameer was a man of stubborn self-will, and his mind once made up, nothing could turn him from his object. The story of his successful struggle to create an army of all arms on the European pattern can be best told by reference to a report drawn up on information supplied by various *sirdars* and artizans since our occupation of Cabul. Lieut. N. Chamberlain, Extra Assistant Political Officer, is the compiler of this valuable report, which gives in detail an account of Shere Ali's steady progress in the armament of his kingdom, until he made the fatal mistake of quarrelling with the British. One cannot fail to be struck with astonishment at the rapidity with which guns

were made, rifles imitated, and cartridges turned out by the 100,000 in a country which boasts of but few resources.

Shere Ali could easily enough make regiments of infantry and cavalry, dress them after the fashion of the men he had seen paraded in India, and drill them in a few simple movements. If he were guilty of the solecism of making Highlanders mount on horseback, there was no great blunder committed; they were his mounted rifles, and were not likely to come to grief, as every Afghan is more or less of a horseman. But in the question of artillery the Ameer had to face a problem which must have cost him much anxious thought. The old brass cannon which had been used for many years as wall pieces in the different fortresses of Afghanistan, sank into insignificance when compared with the guns Lord Mayo had given him. The latter were few in number, and it was all-important they should be multiplied, so that if three or four armies took the field, each should have its due complement of guns. There were skilled artizans in Cabul who had made brass guns, and one of these, named Surferaz, was given funds by Shere Ali and peremptorily ordered to turn out guns in the pattern of the siege train and mountain battery which had lately arrived from India. The unlucky man tried his best, but at the end of a few months his work was pronounced a failure; and as he had spent 12,000 Rs. in his experiments, he was summarily thrown into prison, and all his property confiscated. This was his reward for obeying the orders of a tyrant. But Shere Ali was not to be foiled; and rightly attributing the failure to want of technical knowledge, he sent the uncle of Surferaz, Dost Mahomed, a skilled gunsmith, to Peshawur, to be instructed in the mysteries of rifled guns. Dost Mahomed may be allowed to tell his own story, as it is full of interest. He says:—

"I am a Cabuli by birth, and a gunsmith. My father was a gunsmith before me. After Shere Ali's return from India, I was sent to Peshawur with a letter to Colonel Pollock, the Commissioner there, in which he was asked to allow me to visit the arsenal, and see how the rifled guns were made. I remained in Peshawur for three months, until the permission of Government arrived. I then visited the arsenal daily, and saw exactly how everything was done; and on my departure I was given models of guns in wood, with complete drawings of the details. I returned to Cabul, and with these models and some complete models of rifled breech-loading Armstrongs which had been given to the Ameer during his visit to India, I began work. I had three principal assistants: my nephew, Surferaz (who had then been liberated), Mahomed Ali, and a man named Rashed. Any number of workmen were at my disposal, as I had only to state the number I required and they were impressed from among the city smiths. Before commencing a gun, a sum of money was given to me which I was not to exceed.

"The following were the prices in Cabuli rupees:—

	Rs.
Field gun	1500
R.H.A. gun	1000
Mountain gun	300
" " (laminated steel)	600

"I never either lost or gained much by my contract. The iron for the guns came principally from India—some through Shikarpur, some from Peshawur. A small quantity was procured from Bajour and Zurmut. The core of the gun was first welded by hand on an iron bar, the required length and diameter. Long strips of iron having been placed all round the core, they were well hammered together, and bands of iron placed over all, to keep everything in its place. The gun was then bored out by the machinery at the water-mills of Deh-i-Afghanan. The machinery for these mills was set up by a Hindustani, named Muah Khan. He learned his trade from a negro, named Belal, who was taught by one Ibrahim, a native of Ispahan, who came years ago from Persia to the service of Sultan Jan, late Governor of Herat. The gun was then rifled by hand, the breech-block and details completed, polished by machinery, and handed over to the arsenal. The strength of the guns was never proved by heavy charges being fired out of them, and they were at once taken into use. Out of all the guns I have made only one has burst. I could turn out four or five guns a month if necessary. My pay was 70 Rs. a month, and I occasionally received presents."

This was not a bad example of what perseverance can acomplish; for the guns manufactured are said by our gunners to be very well made, lacking only finish. The Armstrong breech-loaders would be creditable to an English founder, and we are now taking many of them to see if they cannot be used for the defences of Sherpur. A great number of small brass-guns for mountain batteries were also made. The old ordnance was broken up, and new guns were cast in the Bala Hissar arsenal, the boring and polishing being done at the Deh-i-Afghanan water-mills. The alloy used in these brass guns contains a larger percentage of copper than we generally use. The water-mills to which reference has been made can still be seen: a huge wheel with a long wooden shaft, in which the boring-tool was fixed. With such simple means it seems almost impossible that heavy guns could be bored; but still the work was done—slowly, it is true, but effectually. The manufacture of small-arms was not such a success. Kootub-ud-din, a Cabul gunsmith, was placed in charge of the Bala Hissar arsenal, and workmen under his direction made 2000 Sniders and 8000 Enfields. The Afghans placed but little faith in their imitation of our rifles; they found that the breech-action of the Snider would not act, the extractor often failing to throw out the cartridge-case after firing, while the grooving of the Enfields was so imperfect that the barrel quickly got "leaded"—*i.e.*, the grooves were filled with lead stripped from the bullet as it was driven out by the charge. It is worth remarking that in the Ameer's palace were found several rifles of different patterns (the French Chassepôt among them), and each had its Cabuli imitation. No doubt various experiments were made before the Snider was finally adopted. There was never any lack of gunpowder in Cabul, as the Ameer employed six contractors to turn out the quantities he needed. Each mill could make two maunds a day, so that the total daily out-turn on an emergency would be nearly 1000 lbs. These contractors also were ready to start other smaller mills during war-time, so that doubtless a

ton of powder could have been supplied every day so long as funds were forthcoming. The composition of the powder was 75 parts of saltpetre, 10 of sulphur, and 15 of charcoal. Bamian supplied the sulphur, with occasional small quantities from Hazara and the Derajat. Saltpetre abounds near Cabul, and excellent charcoal is made from the thousands of small willow-trees which line every water-course in Chardeh and the near valleys. The coarse-grain powder for muzzle-loading guns was paid for at the rate of 2 Rs. per lb., while that used for breech-loading field guns and for rifles was 3 Rs. per lb. The powder, as a rule, is far inferior to that of European make, as the Afghans do not understand the final process of glazing, which adds so much to the strength of the composition. Shot and shell were strictly copied from the patterns brought from India, but time fuzes were not understood. A bursting charge—the secret of which was held by a Herati—was used, and not until just before the war of 1879 were fuzes made in the Bala Hissar. They are not a success, the delicate nature of the fuze not being properly appreciated. In the matter of small-arm cartridges the Afghan smiths deserve much credit. Sixty of them were constantly engaged in the Bala Hissar arsenal making up cartridges, and their Snider ammunition is excellent. The cases are made by hand, and are technically known as "solid cold-drawn brass." The bases are very strong, and the cases can be refilled many times. In a country where there is no machinery (as in England) for turning out millions of cartridges in a few days, this is a great advantage. Two clever Cabulis, Safi Abdul Latif and Safi Abdul Hak, invented a machine for making percussion caps, equal to turning out 5000 a day. The detonating composition is fairly good, but spoils if the caps are kept for two or three years. Considering there were millions of caps still in the unopened boxes sent from Dum-Dum arsenal to Shere Ali, native-made caps were not much needed. Gun-carriages and limbers were made in the English pattern; the guns captured in the disastrous business of 1841–2 serving as models, in addition to the siege-train given by Lord Mayo.

Among Shere Ali's other improvements in his "war department" was the establishment of a Clothing Department, which had for its object the equipment of his soldiers in proper uniforms. The tunics, trousers, kilts, gaiters, helmets, &c., are all neatly made; and as each soldier received a new uniform every two years, the regular regiments ought to have been smart and well set-up. That they were not so was chiefly due to the laxity of discipline and the incompetence of their officers. Pouch-belts and bayonet-frogs on the English pattern were served out, and the cavalry were all furnished with new swords, slightly curved like those used by our own *sowars*. The steel is generally very soft, but the blade is well tempered, and takes an edge so keen that even a slight blow leaves a deep gash. Shere Ali's ambition, while thus perfecting his armament, was to build a fortress of huge dimensions, and Sherpur was accordingly begun. The subsidy paid yearly by the Indian Government gave him money to lavish in this direction, and the cantonments our troops are now occupying were laid out on a scale that even to European ideas seems enormous. The fortress was to have been in the shape of a huge square, with walls 3000 yds. long, and on the

Bemaru heights, in the middle, a strong citadel was to have risen—the "New Bala Hissar." At the foot of the southern slope, below the citadel, a splendid palace was mapped out, the strong foundations of which even now show how imposing the building would have been. Shere Ali's quarrel with the British put an end to his ambitious schemes, and Sherpur remains to this day incomplete; while, away in the Hazar Darukht defile, thousands of logs are lying, ready squared, which the Jajis had got ready for the barracks which will now never be built.

Lieut. Chamberlain, in summarising the result of his interesting enquiries into Afghan armaments, makes out the following tabular statement:—

Number of Guns previous to War of 1878–9.

English siege-train (elephant)		6
Cabuli " "		10
" " (bullock)		18
Horsed guns...	breech-loaders, 89 brass-guns, 56	145
Mountain guns	breech-loaders, 6 muzzle-loaders, 48 brass, 96	150
Various small guns of position		50
Total		379
Deduct guns captured, 1879–80...		256
Guns remaining in country		123

These are believed to be chiefly in Herat and Turkistan.

The number of rifles entered in the Government books as having been issued to the troops are—

English Sniders	5000
" Enfields	15000
" rifled carbines	1200
" Brunswick rifles	1400
" Tower muskets	1000
" cavalry pistols	1045
Cabuli Sniders	2189
" Enfields	8212
" rifled carbines	589
Kandahari Enfields	453
Herati "	516
Various kinds for cavalry (double-barrelled, &c.)...	1553
Smooth-bores (probably many Tower muskets) ...	1418
Flint muskets	1300
Total	49875

Of these, 742 English Enfields, 560 English Sniders, and 5427 muskets, Cabuli Sniders and Enfields, flint muskets, &c., have been given up, leaving 43,146 small-arms in the country.

It is worth noticing that no information could be got as to whence the English rifled carbines, Brunswick rifles, Tower muskets, and cavalry pistols were obtained. The Brown Besses were, perhaps, part of those taken in 1841–2. This estimate of arms, it should be remembered, takes no account of the many thousands of *jhezails*, native pistols, &c., in the hands of tribesmen. The totals are sufficiently great to prove that the late Shere Ali had placed Afghanistan on such a military footing that he may have well believed he could, with the mountain barriers between Cabul and India, defy any force the British could spare to send against him. He was grievously mistaken: his weakness lying in the want of discipline among his troops, and the incapacity of their leaders. The cost of the army which he had raised and equipped was a serious item in his exchequer accounts, if he ever kept any. Lieut. Chamberlain computes it at 19,21,195 Cabuli rupees, of which 17,81,233 Rs. went for pay to the army, 1,20,235 Rs. for arsenal expenses (not including Herat and Turkistan), and 19,727 Rs. for uniform. Considering that Major Hastings, chief Political Officer here, has calculated the whole revenue of Afghanistan at only 79,82,390 Rs., it will thus appear that nearly one-fourth of the revenue was lavished in military expenditure. The Ameer ought reasonably to have expected his army to have made a better defence of his kingdom against invasion than the weak struggle at Ali Musjid and the Peiwar Kotal. After the present campaign, Afghanistan can never hope to rise to the position it occupied under Shere Ali. The easy capture of Cabul and 214 guns is a blow that even a Dost Mahomed would find hard to recover from; and we have yet to destroy the Bala Hissar before we return to India.

AN ACCOUNT OF THE MARCH OF LORD CHELMSFORD'S COLUMN TO ULUNDI, IN JUNE AND JULY 1879.

BY

LT.-COL. J. T. B. BROWN, C.B., R.A.

In February 1879, as soon as the news of Isandhlwana arrived in England, large reinforcements were at once sent to Natal; and I arrived, among others, at Durban on the 22nd March, and was soon ordered to join Colonel Wood's column on the frontier of the Transvaal. I arrived at Utrecht on April 14th, and as there was no immediate advance contemplated, I was kept here a short time in temporary command; and by the new arrangements of the troops I was appointed to command the Artillery 2nd Division, and I joined General Newdigate's head-quarters at Landman's Drift early in May. The division was then assembling, and eventually consisted of—

The K.D.G.'s and 17th Lancers, under General Marshall,
N/5 R.A., 7-pr. M.L.R. guns, under Lt.-Col. Harness,
N/6 R.A., 9-pr. M.L.R. guns, under Major Le Grice,
Half O/6 R.A., an ammunition column, under Capt. Alexander.

(The artillery of General Wood's column, also under my command, consisted of—

10/7 R.A., 4 Gatlings, under Major Owen,
11/7 R.A., 4 7-pr. M.L.R. guns, under Major Tremlett).

A company of Royal Engineers.

1st Bde. (Col. Glynn, CB., 24th Regt.) — 6 comp. 21st Regt., 6 comp. 58th Regt., and a battalion Natal Native Contingent, under Major Bengough, 77th Regt.

2nd Bde. (Col Collingwood, 21st Regt.) — 7 companies 1/24 Regt., 6 " 94 "

Some local corps of mounted men, Bettington's Horse, and Shepstone's Basutos.

The artillery carried 150 rounds a gun and 50 rockets per battery. I had 50 rounds per gun in 2 ox-wagons, as a 1st reserve with the column, and the Ordnance Store Department had a further supply of 50 rounds a gun near at hand as we advanced.

The infantry carried 70 rounds a man, and 2 boxes in each of the 2 company wagons, which gave 24 rounds a man; and each two companies had a mule-cart drawn by 6 mules with 12 boxes in it, which gave 36 rounds a man; and Captain Alexander had 5 mule-carts, 8 mule wagons, and 3 ox-wagons, which together carried 440 boxes, and was a general reserve for General Newdigate's and General Wood's infantry.

Lord Chelmsford arrived in camp on the 22nd May, and on the 27th the division began to concentrate at Koppie Allein. The head-quarters marched there on the 28th May, crossing the Buffalo by two good drifts just in front of our camp, and getting by a fair road to Koppie Allein. We had two days of wet weather here, and the men were employed making three drifts across the Blood River, which was crossed by the 1st Brigade and N/5 on the afternoon of May 31st, and we encamped in Zululand.

June 1st.—Lord Chelmsford and remainder of the troops crossed early in the morning, and the division advanced about 9 miles, over fine grass land and a succession of gentle rises, until we arrived at a neck of land between the Itelezi and Incensi Hills. We had only crossed one donga, and the march was an easy one. The division laagered by brigades in two small laagers and a large cattle laagar between. Only a portion of the K.D.G.'s came on from Koppie Allein. This evening we heard of the Prince Imperial's death.

June 2nd.—The division halted and the cavalry went out to bring in the Prince Imperial's body. In the afternoon a funeral ceremony took place. The body was carried to the gun-carriage by six artillery officers, and an armed party of the R.A. marched in front of the gun, the head-quarter staff and remaining R.A. officers being mourners.

June 3rd.—The division marched about 9 miles, over undulating ground, perfectly open—not a bush to be seen. The grass seems better than in Natal. There were a few mealie fields about. The mounted men scouted all round, and the division marched with two battalions in column and a battery at full intervals between them, the mule transport and ammunition column next, and the ox-wagons after, 10 or more wagons abreast. The rear brigade followed in the same formation as the leading one, and Bengough's natives kept on the flanks of the wagons. The laager was formed about 800 yds. from where the Prince Imperial's body was found, which was at the junction of four dongas. The laagar was an oblong one, 400 yds. × 180 yds., divided by a traverse of ammunition and staff wagons, the cattle on one side, the greater part of the horses on the other, the tents round the outside beyond the shelter-trench, which was close to the wagon wheels. The climate seems perfection for campaigning: it was not too hot in the day, but there was a bright sun to warm one after the cold nights. The camp was near the Ityotyosi River.

June 4th.—The camp had an alert at daybreak; every tent was struck and the laager manned. The guns were placed three at each angle. At

12.30 the first brigade paraded and marched to the site of General Wood's camp of last night, about 3 miles off, across the Ityotyosi; but as there were two bad drifts to cross, the 2nd Brigade had not moved off before the 1st Brigade was beginning to laager. Just then Lord Chelmsford's Naval A.D.C., Lieut. Milne, rode up to say a Zulu Impi was reported quite close; it was quite dark, however, before the laager—a very large one—was completed. Lord Chelmsford always settled the laager for the 2nd Division himself. No attack took place.

June 5th.—The 2nd Brigade marched off at 7.30, crossed a donga at once, and then with a broad front, as before, advanced 2 miles, till we crossed the Nondwini and laagered 4 miles from the last camp. N/6, the 24th, and 94th took up a position on a ridge some distance in front, while the laager was forming, as the Zulus were reported to be in the neighbourhood. The laager was, as before, rectangular, with a division down the middle and shelter-trench outside, three guns at each angle, and to the right rear a stone redoubt was commenced in which two companies 21st Regt. were to be left. Some messengers from Ceteweyo came in to-day.

June 6th.—Halt. The messengers sent back to Ceteweyo, and the redoubt (Fort Newdigate) continued. About 9.30 p.m. two shots were heard to the left rear, and the "assembly" was sounded by order in the camp, and almost immediately two vollies were fired from the same point as before; and at once a heavy fire of musketry spread all round the laager, and many of the N.N.C. inside the laager sat down and fired up in the air. After a time, a gun was fired from the right front by order of Major Le Grice. The moon was near the full, and there was a fresh breeze blowing many clouds about, which cast moving black shadows on the bare hill sides. After a time the firing was stopped, but not before one round of case and about 4000 rounds M.H. ammunition had been expended. It turned out that a sentry of the 58th and two N.N.C. men thought they saw a man, and fired, running hastily in on their picquet, the 58th man shouting out, "They are coming in swarms!" The officer of the picquet, although he could not see any one, was persuaded by his men to fire two vollies, and thus every one in the camp thought a real attack had taken place. The picquet tried to get back to the laager, but had to run for shelter to the fort building outside.

The 17th Lancers unfortunately lost their Adjutant yesterday, having got near some wood from which the Zulus opened fire upon them.

June 7th.—We marched off at 7.30 a.m., leaving two companies 21st Regt. in the fort. On our road we met General Wood's column returning with empty wagons for supplies. They left many of their mounted men with us, and took five companies 24th also back with them, and 600 or 700 empty wagons from the two columns. We advanced about 9 miles, crossing two dongas and finding the ground much more rocky. About noon we laagered on ground sloping towards the Upoko River, with wooded and broken hills the other

side, and a number of fine hills to the north. Inhlazatye—a bold, dark mountain—in particular is very conspicuous; it is the finest feature in the country. A peculiarity of the country is the number of flat-topped mountains, with the sides in a great measure nearly perpendicular. This is the first place since we left Natal that we have seen any trees, even as big as a currant bush.

Three guns of N/6 fired about 16 rounds of common shell into some kraals about 3800 yds. off, among the trees, and the first shell drove the Zulus out, and we followed them up the hills beyond.

June 8th (*Sunday*).—The mounted men and two guns of N/5 went out round the left of the range of hills in our front, and drove back parties of Zulus. The infantry crossed the river, and advanced into the woods from which we had shelled the enemy yesterday. They found many relics of Isandhlwana among the caves, one of the mule wagons of N/5 being brought back in good order. N/6 took up a position to cover this movement of the infantry. The division halted till June 18th, getting in fuel and giving the horses and cattle a chance of feeding a little better.

The Flying Column returned on the 17th, and moved past us into the valley beyond; the 24th rejoined the 2nd Division, and the mounted men the Flying Column. This consists of two Gatlings, 10/7, four 7-pr. guns of 11/7, the Mounted Infantry Frontier Light Horse, and other local corps, Wood's Irregulars (a corps of native infantry), the 13th and 90th Regts., and five companies 80th. The companies of these regiments are not so strong as those of the 2nd Division; the latter being nearly 100 strong each. Nearly all the K.D.G.'s returned from here.

June 18th.—The division moved off at 7.30, crossing four dongas before we arrived at General Wood's camp of last night, and we passed a good deal of bush, and kept on the S.S.W. side of the hills which we had faced for the last 10 days. We passed Inthlabaumkosi (or the Hill of Alarm) on our right, and descending a steep grassy slope, found ourselves on the old wagon track from Rorke's Drift to Ulundi, and about 2 p.m. were on our new camping ground on the west side of Upoko River, and to the north of the Isepezi Mountain. We were delayed some time getting into laager, as General Wood's wagons had not got across the drift in front of us. The Flying Column encamped just across the Upoko, and from this time the two columns kept well together.

June 19th.—General Wood advanced at daybreak, but as we only had to cross the river and were building a fort here, we did not move off till 12.30 p.m. I then rode forward a good way to see our camping ground for to-morrow. At 10.30 p.m. two shots were heard near the camp, and men stood to their arms, but no firing took place from the laager.

June 20th.—The guns of N/5, two companies 21st, and a squadron 17th Lancers were left here at Fort Marshall. General Marshall and

the cavalry brigade staff had gone back to the frontier from the Upoko camp.

The 24th Regt. and N/6 marched off at 7, so as to get across a bad bit of ground at the top of the hill by 8. We then advanced a little, and outspanned to feed, the wagons doing the same in succession, and about 11 a.m. we began again to advance. A great deal of grass about here has been burnt, as well as some mealie fields. We encamped on the west side of the Ibabanango Spruit, the rear of the column getting in about 4. The laager was 300 yds. × 200 yds., with two traverses across it; great grass fires all round.

June 21st.—The ox-wagons began crossing the spruit at 6.30 a.m., and forming up in succession. The first divisions of them fed the cattle until 9.30, when the leading brigade crossed, and advanced several miles across a fine open plateau, until about noon, when we arrived at the top of a high steep hill looking into a deep valley surrounded on all sides, except towards the south, by steep broken hills, and much intersected by dongas. The leading battery and regiment took up a position here, while the wagons descended into the valley, in the far end of which General Wood's wagons were still to be seen struggling through. Altogether this would have been a very favourable spot for the enemy to have attacked us; but either they were not sufficiently enterprising, or the scouting was so well done by the mounted men under Colonel Lowe, 17th Lancers, and Colonel Buller, 60th Rifles, that the enemy had no chance, and we were never disturbed on the march.

The laager was not completed on the west bank of the Umlatoosi by 5.30, when a violent thunderstorm passed over us, and the 24th Regt., which was the rear-guard, did not get in till past 8. General Wood's camp was on the east bank of the river.

June 22nd (*Sunday*).—General Wood's column marched off early. The 2nd Division halted, and, after divine service, as there was an abundant supply of water, and a hot sun and fresh breeze, the day was employed in bathing, and washing the men's clothes, and the cattle got a good feed, as there was plenty of grass about.

June 23rd.—The ox-wagons began crossing the river at 6.30 a.m., outspanned and fed, the rear divisions of them feeding round the camp. At 9.30 a.m. N/6 and some infantry crossed, and at once moved up a very steep hill, followed by the wagons which had first crossed. It was only by outspanning on the road in this manner that the cattle got any food, as they all had to be in laager soon after 5 p.m., and could not be let out much before 7 a.m.

We continued on a broad ridge for some time, till we came to a sharp descent to our right, and we laagered on one of the spurs of a range of steep hills. General Wood's force was on several spurs to our left rear, but more on the direct road to Ulundi. We could see the kraals about Ulundi to-day for the first time. The country on our right is a bolder range of hills and more wooded, and on these exposed hills it is very cold.

June 24th.—Marched off at 8.30. Two guns of N/5 and two companies 58th Regt. were left here in Fort Evelyn. We proceeded up a very steep hill, and along winding grassy ridges, till we encamped half-way up a steep hill on the top of which General Wood was encamped.

June 25th.—General Wood moved off at daybreak, and at 7.45 a.m. I went with all our guns (now only 8) to take a position on the ridge, so as to cover the camp and ground below while the wagons crossed the ridge. General Wood's column were still moving off the ridge when we got to the top, and they immediately descended into a deep ravine with a bad drift at the bottom where only one wagon at a time could cross. I saw that we should be all day here, so sent the horses to feed below and cooked the men's dinners. At about 3.30 p.m., most of our wagons being now at the top of the ridge, I descended into the ravine, sending all the wagons first, and remaining as long as I could with the guns in position. We went up a very steep hill to our new laager, not three miles from that of last night, but it was nearly 8 p.m. before all the wagons were up. The General dispensed with an entrenchment round the laager, as the natural strength of the position was great, and the infantry had had a very hard day helping wagons up the hill. The artillery, both men and horses, had an easy day, as they rested 6 or 7 hours. An allowance of grog was issued to-night, with ½ lb. extra meat. The ridge we crossed was called the "Ridge of the Little Jackal." The scenery from it was finer than we have seen yet. Inhlazatye still stands out as the grandest feature, while Ibabanango is very prominent to our left rear.

June 26th.—At 8.30 a.m. some Lancers, N.N.C., and two guns N/6 went a few miles to our left front till we came to the edge of the high land overlooking a valley where there were several kraals and a good deal of bush, aloes, and mealie and pumpkin fields. Lord Chelmsford, General Wood, and Colonel Buller with his mounted men, were here, and the latter descended a steep slope into the valley. We soon saw several kraals on fire, and from one large one about 3 miles off we saw about 1000 Zulus advance. We fired a shell at them, and they immediately turned, and then burnt their kraal—said to have been the third largest in the country and the oldest military kraal, having been built by Charka. Buller's men pursued the Zulus among the dongas and bush, and killed a few. The bush in the valley does not seem thick, but a great deal is aloe; trees about 5 to 7 ft. high and at about 400 or 500 yds. off looking just like Zulus. There is a great deal of mimosa, which is dreadfully destructive to clothes. We encamped about 3 miles from last camp, and saw the mission station of Kwamagwasa, about 7 miles off, in flames, and all round there were grass fires.

June 27th.—Marched off at 6.30 about 10 miles over fine open downs; the air fresh and clear, and easy marching. N/6, the 94th, and 21st got to their new camp, close to General Wood's, about 12.30. The valley we saw yesterday was on our left, and an abrupt range of mountains to

our right. We passed a few weird trees in the hollows to-day—the only ones since we left the Upoko. This spot is called "Emton Janeni"—supposed to be the highest ground near here, and 16 miles from Ulundi. We could see Inhlazatye to our left front, Ibabanango to the left rear. We could see a large kraal near Ulundi, with a road up the centre.

June 28th.—Halted, and began to break up camp, so as to leave the stores, reserve ammunition, baggage tents, &c., here, and to form a laager of the few wagons that would go on with us. About 11 a.m. a report arrived that an Impi was advancing; we continued, however, breaking up camp till 2 p.m., when the Impi had advanced so much that a laager was made as quickly as possible. We had no tents to-night.

June 29th (*Sunday*).—After church service the wagons inspanned, and we made a proper separation of the wagons. Two companies 24th Regt. and a few from each regiment, the Ammunition Column, sick, &c., are to remain here under Major Upcher, 24th Regt.

30th June.—Marched off at 9.30 close upon Wood's column, descending by a smooth but steep slope into the valley. We at once found a change of climate; from being on a bleak north-country moor, we came into a tropical climate, with aloes, mimosa, and euphorbia trees, a good many fields of mealies, pumpkins, and melons, and the remains of the kraals burnt on the 26th. On our way we met messengers from the King with the Prince Imperial's sword and a letter which the King had made a Dutchman direct to Lord Chelmsford. This man, at great risk to himself, had written outside, "Take care; he has 20,000 men with him." We lagaared in a small square, about 130 yds. Ten days' provisions are carried regimentally, and as few horses and mules are brought on as possible. I had therefore left three of Major Le Grice's English ammunition wagons behind, bringing the ammunition in ox-wagons. These ammunition wagons do not seem well fitted for the drifts here, and the drag-shoes and chains do not answer at all; they are always breaking.

July 1st.—Marched off about 7, as Wood's column had to clear off first. 94th, 24th, and four guns of N/6 led. The bush got thicker, and the road rocky and sandy, but there was no undergrowth to prevent one riding anywhere. We passed a number of euphorbia trees from 15 to 20 ft. high, but have nowhere seen any well-grown timber; all the trees seem knarled and crooked. The road being very narrow, we only advanced about 8 miles, when we were about 1½ miles from the White Umvoloosi. Here we began to laager in a thick wood, and as the Zulu army was seen apparently approaching the Umvoloosi, we hastily threw up an entrenchment and *abatis*. However, no attack took place, and we laagered as usual. Some slept under the wagons; I preferred the open air, as fresher, and slept just outside Harness' epaulment. The nights were warm and pleasant, and the moon about full; but the grass round was long, and there were trees and bushes close round us on all sides. I had just got off to sleep, when I

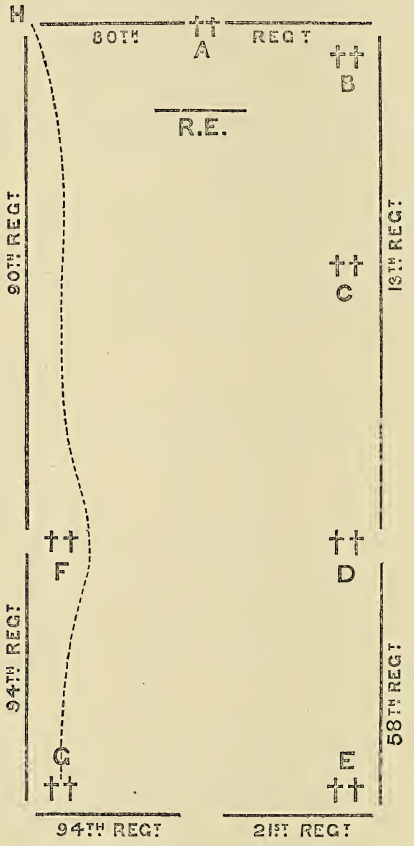
was roused by "Guard turn out!" and the 58th rushed in to man the laager. They were all sleeping outside, and ran into their places. I saw none run beyond the parapets, and the gunners stood at once to their guns. I went round the laager with Lord Chelmsford, and found it all manned. It turned out that a sentry of the 21st, posted in long grass, heard someone approaching, and challenged, but receiving no answer, fired. The persons he heard were two N.N.C. officers returning from visiting their outposts. The shots alarmed the N.N.C., who rushed, assegai in hand, over the 24th Regt., and as the natives always sleep without the few clothes they wear by day, the 24th naturally thought them the enemy, and ran in too; a few men of the picquet ran in, and a few were afterwards tried by court-martial. In the other column a similar scare took place, and also a few European soldiers had to be tried by court-martial. No firing took place except the shots from the sentry; soon after we had lain down a slight alarm took place, but there was no firing.

July 2nd.—A dull morning. We heard of Sir G. Wolseley having gone to join Crealock's column. About noon we moved forward, and joined our laager to Wood's, close to the river, and we built a small stone redoubt on the hill above our laagar, which itself sloped towards the river. I placed two guns of N/6 here.

July 3rd.—I took the two 9-prs. out of the redoubt, as it was to be built up closer, and we were to take the guns on, of course. About noon N/6 took up a position commanding the ford across the river, and about 1300 yds. from a wooded hill from which the Zulus had been firing at us. We saw large bodies moving about on the opposite side, where the country was quite open, and we fired a shell into a donga where we saw a good many, and another shrapnel into the wood, where we saw a good deal of smoke. Buller and his mounted men crossed the river below the camp, and came round the rear of the hill, and soon cleared the enemy out of the caves and bush. I heard after that six bodies were found where our shell had burst. The mounted men charged round out of sight, but we soon heard heavy firing, and the mounted men returned in twos and threes over the hill. I fired one shell to check the pursuit, and they got back to camp, having lost two or three killed. We soon returned to camp, and orders were given for us to advance to-morrow without baggage, only a day's tinned meat and biscuit. About 10 the Zulus began to make a dreadful noise, the singing being of a most weird nature; and although 3 miles off, it sounded quite close. Some thought this meant an immediate attack, and all our horses were brought inside the laager; it turned out, however, that the Zulus had received a large reinforcement.

July 4th.—Battle of Ulundi.—The division roused (without bugle sound) at 4, the *reveille* sounding as usual at 5.15. We crossed the White Umvoloosi at 6.40, the mounted men having previously scouted all round. Five companies 80th led, then a company R.E., 10/7 and 11/7 R.A., and the 13th Regt. in fours on the right, the 90th in fours on the left, then N/5 N/6, with four companies 58th on the right, six

companies 94th on the left, the N.N.C., and then two companies 21st and the 17th Lancers. There was some rough broken ground just across the river, but we were over it before the enemy appeared, and we were on open downs again with long grass. The mounted men now burnt a large kraal on our left, and set alight to Nodwengo; but the fire did not spread, and it was spared for the present, as the smoke blew over us. The division formed now; the 80th 4-deep, the others fours right and left, and the rear face 4-deep, the hospital, wagons, and native infantry inside the square.



Explanation of the Guns.

Major Tremlett.	A.	2 Gatlings.	Major Owen, Lieut. Rundle.
	B.	2 7-prs.	Lieut. Davidson.
	C.	2 7-prs.	Capt. Browne, Lieut. Slade.
Lt.-Col. Harness.	D.	2 9-prs.	Capt. Crookenden, Lieut. Woodhouse.
	E.	2 9-prs.	Major Le Grice, Lieut. Trench.
	F.	2 7-prs.	Lieut. Parsons.
	G.	2 9-prs.	Lieut. Eliot. (These guns came into action at H.)

This square was between 300 and 400 yds. long, and perhaps 150 yds. broad, or rather less than the parade in front of Woolwich

Barracks. The men were in fours, and merely faced outward when halted; they therefore were at double intervals, not like an ordinary square of four ranks. The two kneeling ranks kept their double intervals, the fourth rank closed up, making with the third rank one standing rank at ordinary intervals. The infantry fire from the 2nd Division was principally by vollies, which keep the men much steadier.

The square soon wheeled to its right, advanced towards Ulundi, and soon halted. The guns took up their positions either a little in front of the line of infantry or in gaps formed for the purpose. They unlimbered, and the limbers went inside the square. Masses of the enemy were seen all round at from 2 to 3000 yds. off, and our mounted men were soon engaged. General Wood now asked Lord Chelmsford for two guns to be placed at the left-front angle, and I was going to bring up the two 7-prs. of Lt.-Col. Harness' battery; but Gen. Wood wanted 9-prs., so I sent for the two under Lieut. Eliot from the left-rear corner. The Flying Column now had six guns and two Gatlings distributed along the front of its infantry, with two guns on each flank dividing it from the 2nd Division, while the 2nd Division had two guns on its front and two on each flank. I notice this particularly, because there has often been an impression that the 2nd Division infantry being all young untried regiments, were not so much to be depended upon as the Flying Column. It is, however, quite evident from this disposition of his artillery that Lord Chelmsford did not think so, as he would not in that case have supported his best infantry with nearly all his artillery.

By 8.30 the mounted men were engaged all round, and by 8.45 they were inside the square. The guns opened at about 2300 yds. range, and made good practice before the columns broke up to skirmish. Soon the infantry began, and the attack seemed to be first more on the front and right face. The No. 1 at a 7-pr. at right front angle was killed, and Lieut. Davidson, at the same guns, knocked down by a bullet, almost at the commencement of the action, and these guns began firing case rapidly; the Gatlings also lost two men wounded, and fired about 3000 rounds, but they jammed several times. The fire got pretty heavy from all sides, but so badly directed that it nearly all passed over our heads. At the right-rear angle, where the two guns of N/6 were between the 21st and 58th, the formation of the ground enabled the enemy to approach closer, and the casualties among the officers here was larger. One Zulu was killed within 40 yds. of the square. Major Le Grice's guns made excellent practice; they fired 11 rounds a gun, N/5 fired the same, and 10/7 22 rounds a gun. The Zulus began to retreat about 9.20, and the retreat became rapid and general; the 17th Lancers, and then the mounted infantry, &c., and afterwards the natives, followed them up. Two of Major Le Grice's guns then followed, and made excellent practice at some bodies of Zulus who were reforming on the hills. Captain Crookenden also fired a few rockets into Nodwengo, which had been occupied by the enemy during the action. I rode round the outside of the square with Captain Alexander, R.A., and we counted

about 150 bodies opposite the right-rear angle, and saw one group of 15; each little bush had one or two behind it. They all seemed splendid-looking men, just like the bronze figures frequently dug up in Italy, and kept in the museums at Naples and Rome.

Immediately round the square the dead were nowhere else so thick, and the effect of the Gatlings was not so great as its admirers expected, but against skirmishers in the open was not a favourable opportunity for it. I heard from officers who were out in the pursuit, that when they got to where our guns had played upon the enemy's masses the effects were marked. Those who were in the laager also reported the accuracy of our fire on these masses. The total loss on our side was 103 killed and wounded. The numbers engaged were :—

Europeans.....	4062	Left in laager.	Europeans.....	900
Natives.....	1103		Natives.....	250
Total ...	5165		Total ...	1150

The term European included colonial levies of white men.

We halted about half-an-hour on the ground, buried the dead, and attended to our wounded, and then advanced to about ¾ mile from Ulundi, and halted near a stream, when the men dined. Ulundi, and all the kraals near, were now in flames. There was but little to be found in Ulundi; the King had a small square house, the kraal had about seven rows of huts, with a high fence all round, and a large open space in the centre.

The troops returned to laager about 4 p.m.

July 5th.—The 2nd Division marched back to Emton Janeni, the cavalry and artillery getting into camp before 1 p.m., and got their tents again.

July 6th.—The Flying Column rejoined head-quarters, and all remained here till July 9th. Nearly all the time the wind and rain were dreadful. We lost about 200 head of cattle from the cold and wet, and want of food; the horses suffered a good deal too. Up till now Major Le Grice's English horses had kept their condition wonderfully, and from the time of his landing at Durban, the end of March, till his return to Koppie Allein, he only lost eight horses, of which two were killed in action. Lt.-Col. Harness' horses were all native, and principally bought in the Orange Free State and Old Colony, before there had been so great a demand. They were useful and handy horses for the light guns, and Colonel Harness had them so well trained they were very little trouble. A few mounted men used to drive them to water, or out to feed, just like a herd of cattle; instead of having a man to every two or three horses.

July 9th.—General Wood's column, with two companies 94th and two guns N/6, marched off towards Kwamagwasa.

July 10th.—The 2nd Division marched off under General Newdigate. Lord Chelmsford joined General Wood. We encamped near our laager

of 25th June, and henceforth the division laagered each night in the same manner—viz., two small laagers, with a large cattle laager between, and flanked by the fire from the others. This facilitated matters greatly, as each man and wagon had the same place each night, and therefore found it without confusion.

July 11th.—The guns, 17th Lancers, and 24th Regt. marched off early, the guns and 24th taking up a position on the Little Jackal Ridge, and remained there till the division laagered near camp of June 24th. The nights now are very cold, the dews heavy, and there is little or no grass; our cattle are getting wretched, not being able to recover from the three bad nights on Emton Janeni.

July 12th.—Marched off at 10.30. I got to Fort Evelyn at noon, and remained there till 3, when the rear of the column was coming in. We encamped on the east bank of the Umlatoosi, where Wood encamped on 21st June.

July 13th (*Sunday*).—A company 24th returned to reinforce Fort Evelyn, and the division halted.

July 14th.—We began crossing the Umlatoosi at seven, and it was late before we got into camp on the east bank of the Ibabanango Spruit. Our track is now marked by dead oxen.

July 15th.—Marched off at 8.30, and rode on to Fort Marshall, where I found the detachment of N/5 under Captain Vibart in good order. Lieut. Pardoe, 13th Regt., who yesterday died of his wounds received at Ulundi, was buried here. The wounded must suffer terribly from the jolting along the wagon tracks. We laagered near the Upoko, about two miles from camp of 7th June, down in the hollow. We halted here till 22nd July. The sick, reserve ammunition, 21st Regt., and two companies 24th, marched on 18th July for Landman's Drift.

July 22nd.—The division shifted camp to rising ground nearer camp of 7th July. A good many Zulus came in with a flag of truce; they seemed anxious for peace.

July 28th.—The 17th Lancers, N/5, N/6, the Ammunition Column, five companies 24th, and 170 wagons, marched off at 9, halting an hour at Fort Newdigate, and laagering near the camp of 3rd June. The 2nd Division is now broken up. The 58th remained at last camp, and an entirely new disposition is made of the troops. The 94th and 58th go to the Transvaal. The two Gatlings came up on 26th July from Fort Newdigate. Their horses seemed in worse condition than those of the batteries who had been through the campaign. At 8 p.m. an order arrived for Lt.-Col. Harness to return to Fort Newdigate, to await the arrival of Colonel Baker Russel's column with the other guns of the battery.

July 29th.—We marched to Itelezi Ridge, and laagered a little down the slope on the other side. We met two companies 21st on their way

up the country, and found a fort here occupied by drafts of the 80th and 90th.

July 30th.—As N/6 was ordered to be ready to go to the Transvaal, and N/5 had returned to Fort Newdigate, I asked Colonel Glyn to allow me to go on at once to Landman's Drift for orders, and I arrived there at 3 p.m. with Captain Alleyne. I there found an order for me to return to England, and sailed from Durban on the 16th August. Captain Alleyne, who had been of the greatest assistance as Adjutant to me during the campaign, was at his own request kept in the country, and sent by Sir G. Wolseley to assist in organising the Swazi Contingent.

In this short campaign the troops were remarkably healthy; frequently there were not above 10 or 11 sick in the 2nd Division. The climate was very favourable to campaigning, the country often easy for marching, and the rations were excellent and sufficient in quantity. The absence of spirits was a great advantage. The conduct of the troops was excellent (I only had two men brought before me for punishment), and on the only occasion the troops came into action their steadiness was all that could be desired.

With regard to the nightly scares and cannonadings, of which we have heard so much, there were only three scares of any sort:—

June 6th, when the scare would have ended at once had the officer of the picquet not fired the two vollies, and then only one round of gun ammunition was fired.

June 19th, when a shot was fired outside the laager, and the troops stood to their arms without firing a shot.

July 1st, when a sentry, not getting any reply to his challenge, fired, and the laager was again manned without any shots being fired from it. On this occasion certainly a few men did run in, and were punished for their offence.

On the other hand, it will not do to found the reputation of our new army of young soldiers, and battalions made up from 10 or 20 others the week they leave England, on the results of this campaign. The trial of steadiness under fire was not a great one; nothing gives men more confidence than being under a heavy but badly directed fire, and that is exactly what we had. Our men may do splendidly under a heavy fire, but the fire of good European infantry, supported by artillery, would be a much more serious matter than anything they saw in Africa; and as to the furious Zulu rush, there was nothing in it to shake any man's nerves if he were one of a compact body.

THE FRENCH FIELD GUNS.

(*Accompanied by a Table of the Field Guns of the principal European Powers.*)

EXTRACTED FROM

"THE FIELD ARTILLERY OF AUSTRIA, GERMANY, RUSSIA, ITALY, AND FRANCE,"

BY

CAPTAIN BECKERHINN.

THE French field guns now in course of issue are of the following calibres—viz., 80, 90, and 95 millimètres (3·15, 3·54, 3·74 ins. respectively).

The Reffye guns of 5 and 7, and the mitrailleuses, will be gradually withdrawn from the service.

The carriages, limbers, and wagons of the new guns are of iron. For the present the old 12-pr. limber and wagon is in use with the 95^{mm} gun.

The 80^{mm} and 90^{mm} are for field battery service, the 95^{mm} gun being intended for field batteries of position.

The 80^{mm} gun is also being issued to the horse artillery.

The barrels of these guns are steel. They consist of an inner tube and of six bands of wrought-iron, strengthening the rear end of the inner tube.

There is a small swell at the muzzle. Of the six bands, that nearest the muzzle is of the least diameter, the next four are equal in diameter, and that in rear of the greatest diameter; the second band carries the cylindrical trunnions.

The bore consists of the rifled portion (*A*), the shot seat (*B*), the conical part (*C*), the cartridge seat (*D*), the conical seat of the gas-check arrangement (*E*), and the seat of the breech-closer (*F*).

The diameter of the rifled portion of the bore is of the dimensions (measured from land to land) by which the guns are respectively known—viz., 80^{mm}, 90^{mm}, and 95^{mm}. The 80^{mm} gun has 24 grooves, the 90^{mm} and 95^{mm} having 28.

The rifling of the 80^{mm} and 90^{mm} is from left to right, and that of the 95^{mm} from right to left, the twist being progressive. The seat of the shot is slightly coned. The cone connecting the seats of the shot and of the cartridge is more abrupt. The seat of the cartridge is a smooth cylindrical space, that of the gas-check is slightly coned. The vent communicates perpendicularly with the centre of the cartridge.

The seat of the breech-closing arrangement (*F*) is provided with sharp, strong screw-threads (female), interrupted in three places. There is a conical enlargement to the rear of it. At the rear of the tube is the breech-door, working on a hinge, the bolt (*n*) which holds this door fast, and a safety arrangement (*o*) which ensures the tight closing of the breech.

The breech-closing arrangement for the three different guns varies only in dimensions and in some trifling details.

It consists of the steel screw (*a*), working in the centre of the tube and interrupted in three places, and of the door (*b*), through which the screw works. The door opens sideways, and is so arranged that the screw can be withdrawn from the prolongation of the bore, which is then left clear for loading, &c.

The handle (*h*) and the crank (*k*) are for working the screw. There are three guides, which work in channels in the plain portion of the breech-end of the gun.

The working is very simple.

To open the breech, $\frac{1}{6}$ of a turn is given to the handle and crank. This movement makes the threaded sections of the breech-screw correspond with the plain portion of the breech end of the gun; it also frees the spring catch, which closes again automatically after the completion of the movement. The breech-screw is then withdrawn as far as possible, and, with the door through which it works, is turned on one side. The gun is now ready for loading. To close the breech, bring the breech-screw into the prolongation of the bore, push it in as far as possible, and give $\frac{1}{6}$ of a turn, which engages its threads with those of the breech-end of the gun. The catch again acts automatically, and the safety arrangement keeps the breech firmly closed. The obturator (*obturateur de champignon de Bange*) is somewhat peculiar. It consists of a steel mushroom-shaped head (*p*), with a cylindrical shaft (*q*), fitting into a channel bored through the breech-screw. It can turn in this channel, and is capable of a slight backwards and forwards movement. It is prevented from falling out by a screw-pin, working in a channel round its shaft. Between the head of the obturator and the breech-screw is the packing (*s*), consisting of asbestos and grease, enclosed in strong linen, kept together by two tin cups, and strengthened by metal bands in front and rear.

When the gun is fired the pressure upon the mushroom-head (*p*) forces out the packing, which by its radial expansion closes the bore to the escape of gas.

The	80mm	gun weighs	425 kils.	(937 lbs.)
"	90mm	"	530 "	(1168 lbs.)
"	95mm	"	700 "	(1543 lbs.)

The projectiles for the 80mm and 90mm guns are common shell, shrapnel, and case. The 95mm gun has, in addition to these, a double shell.

The cartridge bags are of amiantine cloth. The powder is of large grain, each grain measuring 6·3mm (about $\frac{1}{4}$ of an inch).

The charge for the	80mm	gun is	1·5 kils.	(3·3 lbs.)
" "	90mm	"	1·9 "	(4·2 lbs.)
" "	95mm	"	2·1 "	(4·6 lbs.)

The iron body of the shells is slightly thicker near the head (its diameter at that point being only $\frac{1}{50}$ of an inch smaller than that of the bore of the gun). The object of this is to centre the shot during its passage through the bore.

Near the lower end of the shell a grooved copper ring is inserted, intended to take the rifling and give the rotation.

The double-walled shell is of two layers; the inner one having 30 pyramidal projections. (See plate.) The outer layer is cast over this. The interior of the shell is completely filled with powder.

In the case of the 80mm gun, 30 rounds are carried with the gun and 90 in the wagon.
" 90mm " 24 " " 72 "
" 95mm " 18 " " 72 "

About one-fourth of the projectiles are shrapnel.

The peace establishment of a French battery is as follows:—

	Field Battery.	Horse Battery.
Captains	2	2
Subalterns	2	2
N.C.O's.	22	22
Trumpeters	2	2
Artificers, &c.	8	8
Gunners	70	72
Riding horses	27	57
Draught "	32	28
Total	106 men. 59 horses.	108 men. 85 horses.

A battery consists of 6 guns, 9 wagons, 1 G.S. wagon, 1 forge, and 1 forage wagon.

95mm Gun.

Range in yds.	Angle of elevation.	Angle of descent.	Time of flight in secs.	Derivation.	Mean deviation in ft.	
					Longitudinal.	Lateral.
	° ′	° ′				
547	0 33	0 53	1·25	0·15	41	1
1094	1 32	2 1	2·64	0·4	39	2
2188	3 53	5 14	5·91	1·82	40	4
3282	6 53	9 40	9·80	5·01	46	7
4376	10 33	15 11	14·50	10·20	53	10
5470	15 13	21 56	19·80	18·30	63	17
6564	21 5	—	25·53	30·2	81	26
7658	28 30	—	—	49·8	125	41
7713	33 17	—	—	69·0	166	60

Mean Deviation of the 90mm and 80mm Guns.

Range in yds.	90mm gun. Mean deflection in ft.			80mm gun. Mean deflection in ft.		
	Longitudinal	Lateral.	Perpendicular.	Longitudinal.	Lateral.	Perpendicular.
1094	42	3	1	83	3	3
2188	50	7	4	84	5	7
3282	62	13	8	85	10	14
4376	76	20	18	89	18	27
5470	102	30	33	109	28	52
6564	132	38	—	152	52	—

	Austria.		Germany.		England.			Italy.		Russia.			France.		
					9-pr.										
	8cm	9cm	Light 8cm	Heavy 9cm	Field battery.	Horse artillry.	16-pr.	7cm	9cm	Light gun.	Cavalry gun.	Field battery gun.	80mm	90mm	95mm
Calibre ..... ins.	3·15	3·5	3	3·46	3	3	3·5	3·15	3·5	3·5	3·5	5·8	3·15	3·5	3·7
Weight ..... lbs.	660	1074	860	995	672	883	1323	661	1074	1011	793	1112	940	1189	1543
Material	Steel-bronze.		Krupp's cast steel.		Steel and wrought-iron.			Bronze.	Cast steel.	Krupp's cast steel.			Steel and wrought-iron.		
Nature	Solid tube.		Hooped tube.		Hooped tube.			Solid tube.	Hoopd.tube.	Hooped tube.			Banded tube.		
Breech arrangement	Flat wedge.		Round wedge.		Muzzle-loader.			Round wedge.		Round wedge.			Axial screw.		
Shot takes rifling by	Copper rings.		Hard lead coating.		Bronze studs.			Soft ld. coats	Copper rings	Centre ring & copper band.			Copper band.		
Carriages	Iron.		Iron.		Iron.			Iron.	Wood.	Iron.			Iron.		
Weight of gun and limber equipped for service ..... lbs.	3424	4226	3968	4277	4016	3708	4784	2749	—	4045	2827	—	—	—	4842
Do. of wagon	4184	4599	4235	4750	4529	4529	4659	2903	—	4659	—	—	—	—	—
Each horse draws gun with gunners on limbers.	703	838	—	868	679	771	646	875	—	825	—	—	—	—	901
Each horse draws gun with without gunners on limbers.	571	705	661	705	670	617	507	687	—	674	617	—	—	—	806
Each horse draws wagn. with gunners on limbers.	751	846	—	979	—	942	964	911	—	907	—	—	—	—	—
Each horse draws wagn. without gunners on limbers.	696	767	705	791	751	751	776	725	—	781	749	—	—	—	—
No. of rounds per gun carried...	152	128	153	135	148	148	100	160	130	152	156	126	162	132	132
" guns to a battery	8 (6)	8	6	6	6	6	6	8	8	8	6	8	6	6	6
Total No. of field batteries	195		300		58 at home; 57 abroad.			140			297			323	
" guns	1540		1800		348 at home; 342 abroad.			1120			2276			1938	
Initial velocity ..... fs.	1384	1470	1526	1457	1381	1381	1348	1312	1490	1334	1509	1296	1608	1492	1443
Greatest range, com. shell...yds.	4920	4920	7430	7650	3830	3830	4000	3900	5800	6890	6890	—	Over 770		—
" shrap. " "	2400	2400	2730	2730		3000		2800	3800	2800	2800	—			1650
No. of pieces shell bursts into	150–200		150–200			36		150–200		140		200–300		70–80	
" balls in shrapnel	124	186	140	230	80	80	176	100	175–179	190	190	300	—	—	—
" " case	72	120	76	76	108	108	130	61	226	76	76	171	—	—	—
At the following ranges 50 per cent. of the rounds will strike an object of the size shown in the columns. At 546 yds. ... long	13·5	16	17·5	17·5	—	—	—	15·3	10·9	19	17·5	—	—	—	16
" 1093 " ... "	13	17	20·8	19·7	—	—	—	19	12	21·9	19·2	—	33	16·5	15·3
" 1640 " ... "	13·5	17·5	24·3	23	37	37	25	26	12	26	25	—	—	—	15·5
" 2187 " ... "	16	20	27·3	25	35	35	—	31·7	14	28	30	—	33	20	15·5
" 3280 " ... "	30	32·5	37	31·7	44	44	—	43·7	20·8	29	36	—	33·5	24	18
" 546 " ... broad	0·2	0·2	0·3	0·3	—	—	—	0·4	0·2	0·2	0·3	—	—	—	0·4
" 1093 " ... "	0·9	0·8	0·8	0·7	—	—	—	0·9	0·5	0·4	0·9	—	1	1	0·8
" 1640 " ... "	1·7	1·4	1·4	1·8	1·6	1·6	1·4	1·6	1	0·8	1·6	—	—	—	1·2
" 2187 " ... "	2·9	2·5	2·2	1·2	3·6	3·6	—	2·5	1·9	1·5	2·6	—	2·1	2·6	1·7
" 3280 " ... "	6·7	6·2	3·9	3·3	5·8	5·8	—	5	4·4	3·6	5·7	—	4	5	2·8
" 546 " ... high	0·2	0·2	0·3	0·3	—	—	—	0·3	0·2	0·2	0·4	—	—	—	—
" 1093 " ... "	0·6	0·7	0·8	0·8	—	—	—	1·2	0·6	0·8	1	—	1	0·6	—
" 1640 " ... "	1·2	1·2	1·7	1·5	2·9	2·9	1·8	2·3	0·9	1·4	1·8	—	—	—	—
" 2187 " ... "	1·8	2·2	0·3	2·8	4·7	4·7	—	4·4	1·6	3	2·4	—	2·8	1·6	—
" 3280 " ... "	—	—	—	—	12	12	—	12	4·3	7	5·5	—	5·7	3·6	—

Fig. 6.

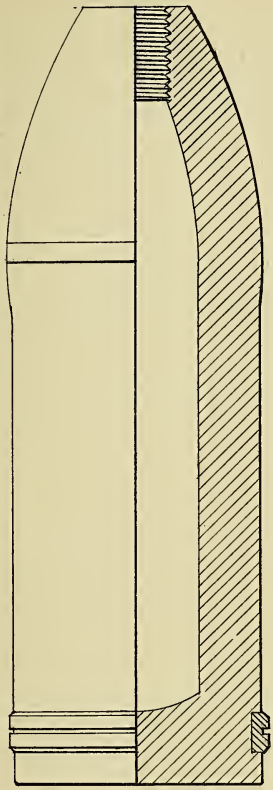


Fig. 7.

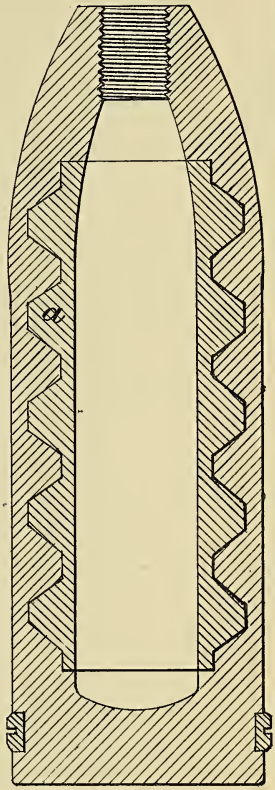


Fig. 11.

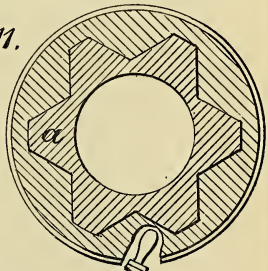
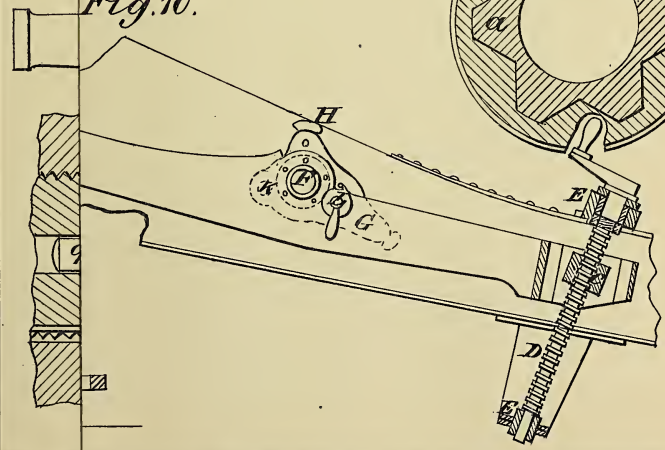


Fig. 10.



FRENCH FIELD ARTILLERY MATERIAL.

Fig.1.

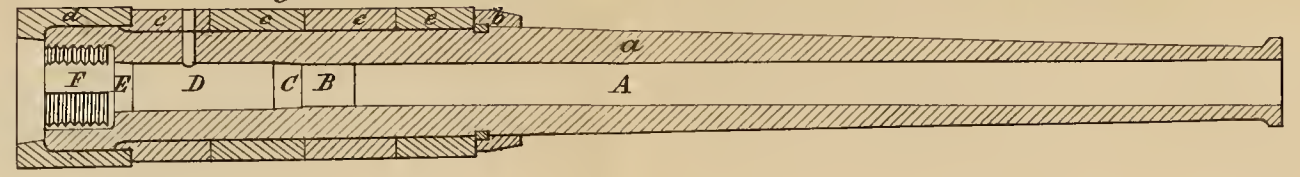


Fig.2.

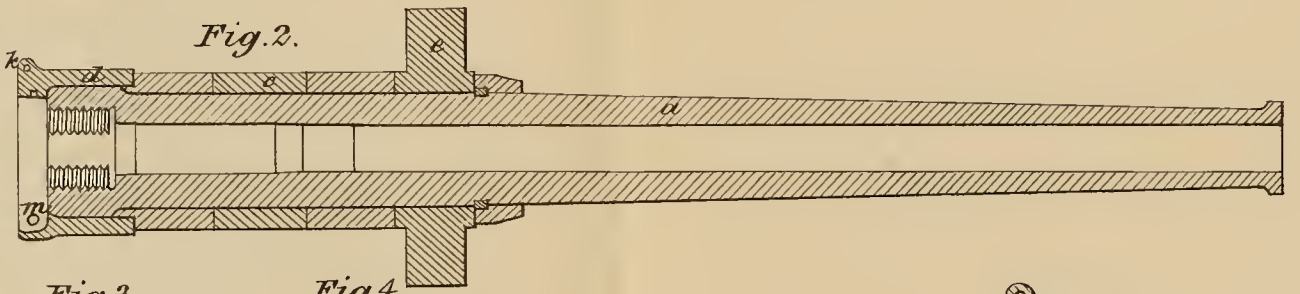


Fig.3.

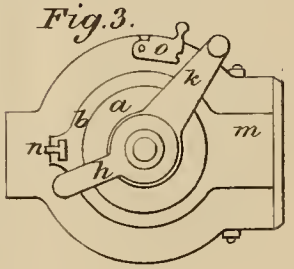


Fig.4.

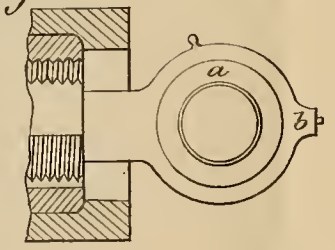


Fig.5.

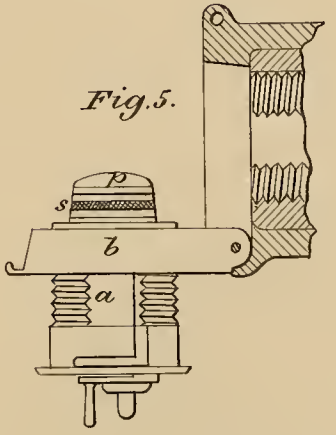


Fig.6.

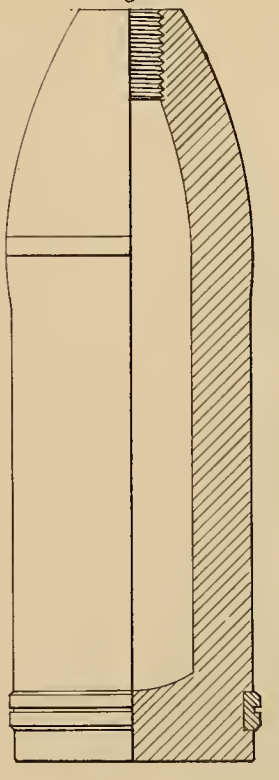


Fig.7.

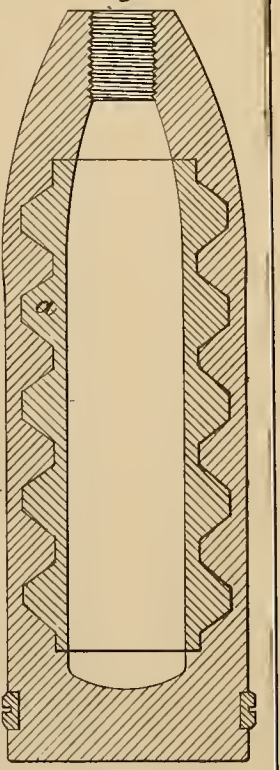


Fig.8.

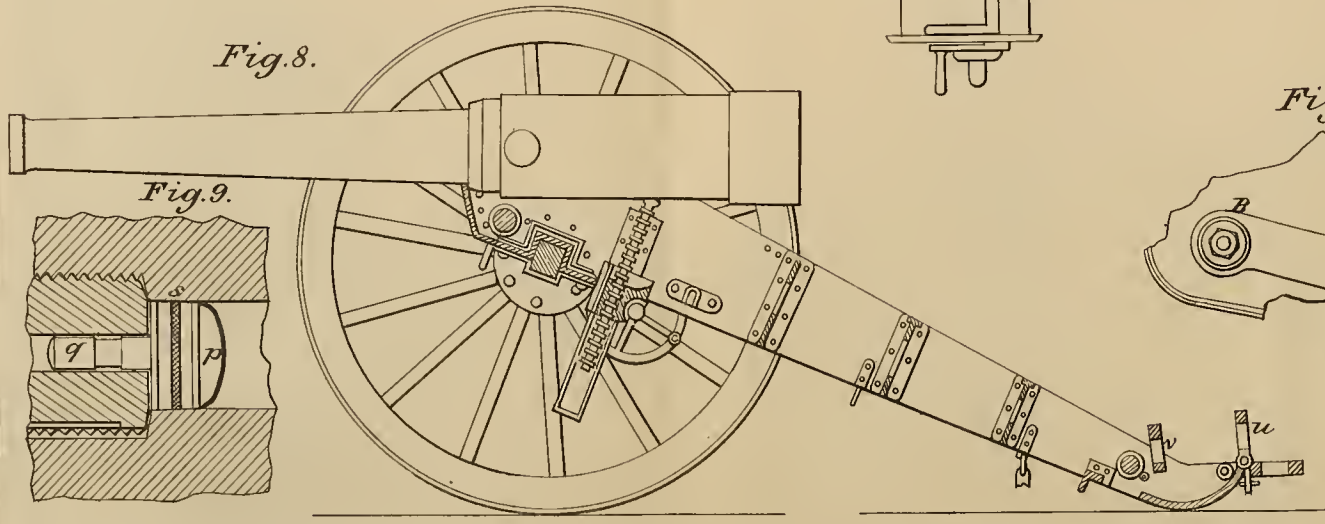


Fig.9.

Fig.10.

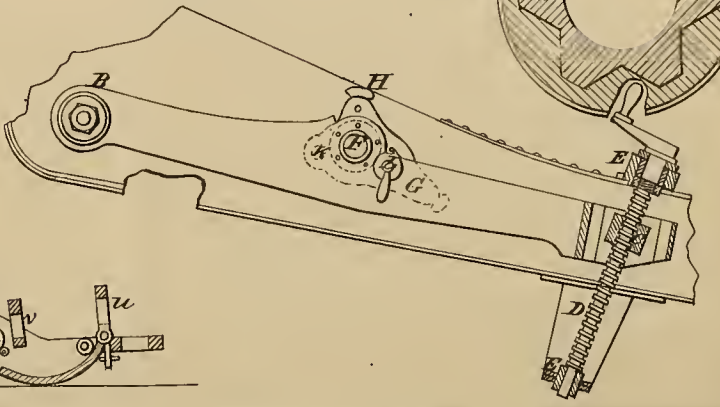
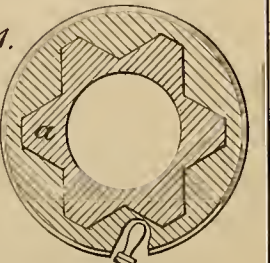


Fig.11.



SHORT NOTES ON THE 13-PR. M.L. GUN.

BY

MAJOR S. J. NICHOLSON, R.H.A.

As the new field gun lately issued for trial differs in many points from any system hitherto adopted in the service, it is hoped that the following short notes may not be uninteresting to those officers who have not had an opportunity of seeing it, or the official Handbook containing its description. It is not intended to give a detailed account, but to state as briefly as possible the main points of difference.

The Gun.

Dimensions.

	Total length		7 ft. 8 ins.
	Weight, average		8 cwt.
Bore	Calibre		3·0 ins.
	Length		7·0 ft.
Chamber	Diameter		3·15 ins.
	Length		14·13 ins.
Rifling, modern polygroove	Length		5 ft. 9 ins.
	Grooves	number	10
		depth	.05 in.
		width	·509 in.
	Vent from end of bore		7 ins.

The bore.

An enlarged powder-chamber is given, "with a view to obtain increased muzzle velocity, and therefore a longer range, a lower trajectory, and greater energy than existed in any previous service field gun, without increasing the corresponding strain upon the piece." The diameter of the cartridge being slightly under 3 ins., it has, when in the powder-chamber, a certain air-space round it; thus each lb. of powder has 35·3 cubic ins. in which to burn, as compared with the 26 cubic ins. of the present system. This is expressed by saying that the density of the charge is 35·3 cubic ins. to the lb. It is this

reduction of density which enables us to fire the comparatively large charge of the gun, 3 lbs. 4 ozs.

The great length of the cartridge, and its being of R.L.G.[2] powder, which burns more slowly than R.L.G., necessitates (1) an increased length of bore, and (2) centre-venting, in order that it may be entirely consumed.

Choke. To ensure regularity of shooting, it is necessary that the density of the charge should always be the same. To effect this the projectile is prevented from entering the chamber by a choke, or concentric contraction of the bore for about 3 ins., having a slight incline on either side. In loading, the gas-check of the projectile coming in contact with the front incline is brought up at the same point each round; in addition to this the choke closes all windage.

Rifling. The rifling is polygroove, and consists of ten shallow grooves. This system distributes the strain round the bore at a great number of points, and the gun is weakened to a far smaller extent than in the old system. The form of groove is symmetrical, the loading and driving sides being alike; the twist, uniformly increasing from 1 turn in 100 in front of the choke to 1 in 30 at 9 ins. from the muzzle, then remains uniform at 1 in 30 for the remainder of the bore. There is therefore a very small initial strain on the gun due to rifling, and the projectile is steadied on leaving the muzzle.

Vent. The vent-bush is fitted by hand, and filed down roughly to get rid of the troublesome process of cutting it off flush, and consequently a small portion is left projecting into the bore.

To enable the cartridge to be ignited near the centre, the vent is placed 7 ins. from the end of the bore. This position of the vent leads to a considerable amount of residue being left in the chamber, especially when blank charges are used. Careful watch should therefore be kept that danger does not arise, especially as the sponge, having to pass the smaller bore and choke, must be of very low gauge compared with the chamber.

Sights. The system of sighting is new; it consists of—

1. A tangent scale, nearly the same as the service pattern, having in the leaf an ordinary notch, ·06 in. deep, protected by rising planes on each side. Below this is a cupped recess, having in its centre a small hole, ·05 in. in diameter, for fine sighting.

2. A bronze block, with keep-pin fitting into a slot in the dispart patch. This block is furnished (*a*) with a fore-sight of bronze in the form of a point, for rough laying in conjunction with the notch of the tangent scale, (*b*) with a reading window and cross-wires, for fine laying in conjunction with the eye-hole.

The sights are not as yet inserted at an angle to correct permanent deflection, nor are the bars of the tangent scales marked with ranges in yds. and lengths of fuze, owing, no doubt, to the fact that modification might be found to be necessary, either in charge or projectiles, during or after the trials, and before the actual adoption of the gun into the service.

FitzRoy's deflectors are fitted to the guns of "A" Batt., "A" Bde., R.H.A., and add materially to the excellence of practice. When firing, however, at even ordinary ranges, on by no means exceptionally bad ground, it was often found that the amount of correction to be given on the deflection scale was over 30′, the length to which it is graduated. Much time was constantly lost in levelling the wheels when this was the case.

Marks. A line is cut to show where base of shell should rest when home, and another the end of the bore.

Elevating gear. In consequence of the length of the gun, it is always necessary, before limbering-up, to run the elevating gear down till the breech rests on the upper transom of the carriage.

The system adopted gives great quickness, in order to avoid loss of time. It consists of an arc attached to the cascable of the gun, having teeth cut in the rear edge, geared into a pinion on the same shaft with a worm-wheel fitted into a friction cone. The worm-wheel is geared on its shaft by a friction cone, adjusted by a nut and keep-nut outside the covering; the object being to allow a slight slip when the gun is fired, while there is at the same time sufficient friction to admit of elevation and depression being given. From various causes the friction cones have to be constantly adjusted, and it is as well to have the spanner always ready for the nuts.

The play which it has been found necessary to give between the different parts of the elevating gear, in order to prevent jamming, is, as in our other systems, a fruitful source of error in range. As the reason for this is not very generally known, it may be briefly explained here. To support the breech firmly it is necessary that the upper surface of the cascable-pin should be in contact with the cascable, the lower surface of the elevating arc with the upper of the worm. The exact contrary is the case if elevation is the last motion given; and the lowering of the tangent scale and inserting the friction tube is sufficient to force the breech down. The resulting errors of elevation were found in some 16-pr. and 9-pr. M.L. guns which had been some time in use to be as much as 10′, and in one case 13′. In some of the 13-prs. it is as much as 10′ at the present time, and will doubtless increase. This at short ranges would give 90 yds. error. The simple precaution is always to end with depression, or to bring the supporting surfaces into contact by gently reversing the wheel until there is a slight pressure against the hand, when ending with elevation.

Brake. A self-acting rachet brake is attached to the rear flange of each gun-wheel. This is used only when firing; in travelling the pawl is secured out of gear by a sliding collar on the guard-iron. The brake-band is kept in adjustment by tightening the screw, and is held during recoil by the self-acting pawl. The band should exert as much frictional resistance as possible, without actually skidding the wheels; a "tommy" for its adjustment is carried under the back of the near axletree-seat. During firing it requires constant attention, and the drag-shoe will often be found more certain and less troublesome.

Handspike. The handspike will, in all probability, be altered, as it is not a success. It need not, therefore, be described.

Limber. The boxes are held by a nib-iron in front and a clip in rear; the guard-irons folding down on to the top. They open to the rear by the side folding down.

Projectiles.

Shrapnel shell. The body of the shell is of cast-iron unturned, without studs. At the base is a projection having an undercut groove and radical grooves. The gas-check is attached by the first to the projectile, and by the second imparts rotation to the shell.

It contains 116 bullets of 34 to the lb.

Dimensions.

Diameter	2·97 in.
Length (over all)	10·17 in.
Weight (filled and fuzed)	13 lbs. 4 ozs.
Bursting charge	¾ oz.

Common shell. Outwardly the common shell resembles the shrapnel in every respect, except that its length over all is 10·64 ins. It is the same weight filled and fuzed.

Case. Contains 285 bullets of 34 to the lb., and weighs 13 lbs. 9 ozs.

Cartridge. Cartridge: service silk cloth, 3 lbs. 2 ozs. R.L.G.[2]

Fuzes.

Percussion	R.L., Mark II.
Time fuze. Wood, time	15 secs. B.L.

The latter has a central composition and six powder channels. It is marked in whole numbers and halves up to 30. As these neither represent tenths of an inch, nor seconds of time, it is better to call them simply divisions. The fuze, when in good condition, burns 13 secs. with this gun when fired at the sea-level.

A B.L. fuze is rendered necessary by the almost entire absence of windage, due to the use of the gas-check.

Practice Table.

A practice table, containing almost every item required, is given in the Handbook for this gun, in place of the bare range-tables to which the service has been restricted hitherto. The advantage of this need hardly be pointed out.

The following specimen for a few ranges may be interesting.

13-pr. Rifled M.L. Gun. 8 cwt. Charge, 3 lbs. 2 ozs. R.L.G.[2] Projectile, common shell or shrapnel, 13 lbs. 4 ozs. M.V. = 1595 f.s.

Range.	Drift, right.	Elevation.	Deflection, left.	Time of flight.	Angle of descent.	Remaining velocity.	5′ elevation increase or decrease, range by	5′ will alter point of impact, vertically or laterally, at each range.	50 per cent. of rounds fired should fall within			Fuze scale.	
									Length.	Breadth.	Height.	Range.	Length of fuze.
yds.	yds.	° ′	° ′	secs.	° ′	f.s.	yds.	yds.	yds.	yds.	yds.	yds.	
500	0·08	0 19	0 1	1·28	0 51	1376	55·5	0·72	4·70	0·30	0·06	480	2·0
1000	0·40	1 6	0 1	2·56	1 59	1195	50·0	1·45	12·15	0·77	0·36	960	4·5
1500	1·22	2 2	0 3	3·87	3 21	1060	41·6	2·18	18·00	1·14	1·02	1470	7·5
2000	2·45	3 6	0 4	5·30	5 1	974	35·7	2·91	23·25	1·44	2·05	1990	11·0
2500	4·20	4 22	0 6	6·90	7 1	914	29·4	3·63	27·75	1·69	3·45	2500	15·0
3000	6·70	5 47	0 8	8·78	9 21	862	29·4	4·36	31·95	1·92	5·30	2980	19·5
3500	10·30	7 18	0 10	10·87	12 6	816	25·0	5·09	35·40	2·12	7·60	3500	25·0
4000	16·45	9 0	0 14	13·10	15 6	774	23·8	5·81	38·40	2·28	10·40	3900	30·0
5000	39·70	13 1	0 27	17·92	22 10	703	17·2	7·27	46·94	2·69	—	—	—
6000	107·50	19 6	1 2	23·70	30 42	644	9·8	8·73	57·44	3·15	—	—	—

The increments of fuze are exceedingly good, as will be seen from the following table :—

Range.	Increment, one to one division of fuze.
Up to 480 yds.	120 yds.
480 „ 780 „	100 „
780 „ 1230 „	90 „
1230 „ 1710 „	80 „
1710 „ 2000 „	70 „
2000 „ 2300 „	65 „ (average.)
2300 „ 2620 „	60 „
2620 „ 3280 „	50 „
3280 „ 3460 „	45 „ (average.)
3460 „ 3900 „	40 „

The cones of dispersion are not given, but the writer has reason to believe, from a few diagrams of practice at Shoeburyness, that they do not materially differ from those of the 16-pr. in the earlier ranges; he would therefore be inclined to suggest the following as approximate :—

Up to 1000 yds.	8°
1000 „ 2000 „	9°
2000 „ 3000 „	10°
3000 „ 4000 „	11°

These cones will give the fronts covered in terms of the distance of the opening of the shell as follows:—

For 8°	.....	·14 of the distance.
" 9°	.....	·15 "
" 10°	.....	·17 "

The angles of descent are only approximate, but must be near enough the truth for all practical purposes.

The angles of ascent after graze are not given, but from the greater length of the projectile they are most probably even greater in proportion than those suggested by the writer for the 16-pr. guns. It is to be regretted that this factor, and that of the retardation due to graze, have not been ascertained, as both must be stated approximately before the path and power of the bullets of the shrapnel fired with percussion fuzes can be known.

The two columns of increase and decrease of range by elevation, and of the alteration of the points of impact vertically, might with advantage be given in 3′, not 5′, as the former is the division of the tangent scale. In addition, the vertical heights due to 10 yds. in range might be given for each angle of descent. The latter would be of great value in solving practical questions. For instance, firing at a gun detachment 2000 yds. distant, the shell are judged to strike 30 yds. beyond: do they pass over the heads of the men or not? The value of 10 yds. would appear in the table as 2·63 ft. The shell, therefore, is 7·9 ft. above plane; in other words, just too high. Again, a shrapnel with time fuze is judged to burst 100 yds. short at the same range, and 30 ft. above plane: is this a good shell? Yes; 26·3 ft. is the height due to the angle of descent, so that 30 ft. above plane is very little below what would be the trajectory of the shell which would strike the centre of a target of the ordinary height.

Short extracts from the report of the practice of "A" Batt., "A" Bde., R.H.A., at Okehampton, are appended, with a view of showing what was done with the gun at practical targets under, as nearly as possible, service conditions. It is not pretended either that the practice was very good in itself, when the great accuracy attainable by the weapon is considered, or that the questions proposed for each day's practice were in any way conclusively settled. Simply it is hoped that the description may prove interesting, as being one of the first experiences of an entirely new gun, and especially that it may lead the way to further experiment in practical directions, with a view of settling some vexed questions as regards the best projectile and fuze under varying conditions.

OKEHAMPTON, 28. 8. 79.

Targets Employed.

No. 1 Target.—A dummy gun and limber with detachment on the crest of a gentle slope. The gun retired so that only half the wheels were seen from the battery, the limber almost invisible.

No. 2 Target.—Similar to No. 1 in every respect.

No. 3 Target.—Similar to No. 1, except that the limber was placed as if in the interval—viz., 9½ yds. to the right, instead of directly in rear of the gun.

Objects of the Practice.

1. To contrast the effect of common and shrapnel shell used with either percussion or time fuzes, under precisely similar conditions, as in the case of Nos. 1 and 2 Targets.
2. To ascertain whether the limbers would be in a position of greater safety if placed in the intervals, instead of, as at present, directly in the line of fire.

During this day's practice the light was very bad; the fog, at times, almost obscured the targets, and a strong wind was blowing across the range. After the first round it was found impossible to distinguish the signals from the range party.

By a mistake in the orders, the range party did not give the results at each range while percussion fuzes were being fired. It may, however, be remarked that as much or even more damage appeared to have been done at the long than the shorter ranges.

Results of Practice.

Percussion Fuzes.

No. 1 Target.—Amount of ammunition, 20 common shell. Point of trail broken, 5 splinters in the carriage, 1 spoke of the limber broken, 2 men disabled.

No. 2 Target.—Shrapnel shell. Carriage and detachment completely destroyed, estimated No. of hits 60, in limber 9 hits.

No. 3 Target.—Shrapnel shell. Left wheel and whole detachment destroyed, estimated No. of hits 23, limber untouched.

Time Fuzes.

Range, 1800 yds.:—

No. 1 Target.—10 common shell. 4 splinters on carriage.

No. 2 Target.—10 shrapnel shell. Whole detachment disabled, 15 hits, limber 2 throughs.

No. 3 Target.—10 shrapnel shell. Whole detachment disabled, 16 hits, limber 2 throughs.

Range, 2060 yds.:—

No. 1 Target.—3 common shell. No results.

No. 2 Target.—2 shrapnel shell. 3 hits on limber.

No. 3 Target.—2 shrapnel shell. 3 hits on gun.

Range, 1200 yds.:—

No. 1 Target.—7 common shell. No results on gun, on limber 1 splinter.

No. 2 Target.—7 shrapnel shell. 4 hits on gun.

No. 3 Target.—7 shrapnel shell. 7 hits on gun.

The value of this last series from an experimental point of view was greatly decreased by the fact that the light became so bad as to necessitate an early withdrawal from the longest range, and also from the targets being already so greatly injured during the first series as to render it almost impossible to identify fresh hits with any certainty.

Deductions.

Common shell, at any range or with any fuze, would appear to give but very meagre results.

Shrapnel shell, with percussion fuzes, appear to have given excellent results on the gun; in the case, however, of the limber placed in the interval, it was harmless. This result might suggest some further experiment with limbers in similar positions.

Shrapnel shell, with time fuzes, had the same effect on limbers placed in either position. At the 1800 yds. range, during the practice at which the light was good, the effect was equal, if not superior, to that of the percussion fuzes; the whole practice cannot, however, be taken as fairly representing the power of the shell at the two last ranges.

OKEHAMPTON, 29. 8. 79.

Targets Employed.

Nos. 1 and 2 Targets.—Two gun-pits on the same position of the guns of the first day, about 30 yds. apart. Guns and detachments in the pits; a 6 × 6 target in rear of each, for the purpose of obtaining information as to the amount of ground covered by the fire.

Object.—To contrast the effect of common and shrapnel shell fired with both descriptions of fuzes.

No. 3 Target.—A shelter trench, 40 yds. long, parapet 2 ft. 6 ins. high; general direction inclined at an angle of 40° to the line of fire, and manned by 55 half dummies.

Object.—The same as before.

Results of Practice.

Range, 2000 yds.:—

No. 1 Target.—8 common shell, percussion fuze. Right side of parapet destroyed, 1 gun spoke broken, 4 dummies hit by 1 splinter, each target in rear 3 splinters, and 1 shell through.

No. 2 Target.—8 shrapnel shell, percussion fuze. Gun and detachment completely destroyed, target in rear 5 throughs.

No. 1 Target.—8 common shell, time fuze. Gun and detachment untouched, target in rear 1 shell.

No. 2 Target.—8 shrapnel shell, time fuze. 4 hits and splinter on carriage, 2 dummies disabled, target in rear 8 throughs.

Range, 1800 yds.:—

No. 1 Target.—5 common shell, percussion fuze. Gun and carriage splintered, 3 dummies hit, target in rear nil.

No. 2 Target.—8 shrapnel shell, percussion fuze. Carriage and whole detachment hit, 25 bullets, target in rear 2 hits.

No. 1 Target.—8 common shell, time fuze. Cheek and axletree of carriage broken, 4 dummies hit, target in rear 3 hits.

No. 2 Target.—8 shrapnel shell, time fuze. Gun and whole detachment hit, 27 hits, target in rear 5 hits.

Range, 1200 yds.:—

No. 1 Target.—14 shrapnel shell, time fuze. Gun dismounted, 2 dummies hit, target in rear 14 hits.

No. 2 Target.—14 shrapnel shell, time fuze. 2 dummies hit, target in rear 5 hits.

The whole of this last series having been fired with time fuzes was due to a mistake of orders. Percussion might have given better results, as the trajectory of the bullets with time fuzes is very flat at such short ranges, and the parapet of the gun-pit therefore affords an increasing amount of cover; the amount of ground covered in rear, however, becomes very considerable.

Deductions.

Common shell with percussion fuze is always beaten by shrapnel with either fuze. The use of time fuzes diminishes its effect still further. Shrapnel shell with percussion fuze appears more effective than with time fuze at the pits themselves; the latter gives, however, very good results, and covers far more ground in rear than the percussion fuze.

Shelter Trench.

Range, 1500 yds.:—

No. 3 Target.—12 common shell, percussion fuze. Breach in right flank of trench, 4 dummies down, none hit.

20 shrapnel shell, percussion fuzes. 11 dummies hit by 12 bullets, parapet very much injured.

20 shrapnel shell, time fuzes. 10 dummies hit by 13 bullets, 2 dummies down.

Deductions.

Again common shell seems to be almost useless. The effect produced by percussion or time fuzes, with shrapnel shell, is almost identical, and not very satisfactory; no doubt a longer range and larger angle of descent would give better results, as in the case of the gun-pits.

As an instance of the accuracy of the practice on this day, it may be remarked that when using percussion fuzes 19 out of 30 shells struck the parapet, and that only one was 20 yds. over; the rest were within 10 yds. The parapet was only 2 ft. 6 ins. in height.

OKEHAMPTON, 30. 8. 79.

Targets Employed, Infantry Formation.

1st Line.—64 half-dummies in two ranks, covering 22 yds. front.
2nd Line.—120 yds. in rear, 35 dummies in single rank.

Range, 1880 yds. :—

1st Line. { 2 shrapnel shell, percussion fuze.
{ 10 " time fuze.
2nd Line. 8 " "

Results.

1st Line.—34 dummies hit by 64 bullets.
2nd Line.—17 " 34 "

Second series, same range :—

1st Line. { 12 shrapnel shell, time fuze.
{ 11 " percussion fuze.

Results.

1st Line.—16 dummies hit by 29 bullets.
2nd Line.—10 " 13 "

Deductions.

As a larger proportion of time fuzes was used in the first than in the second series, and the results in the former were far superior to those in the latter, it may safely be inferred that time fuzes are superior for infantry formation in the open.

OKEHAMPTON, 1. 9. 79.

The practice this day was at two targets, placed respectively at 3700 and 3000 yds. Shrapnel, percussion, and time were used. To avoid describing it in detail, it may be stated that at 3700 yds. nearly the whole of the shells with percussion fuzes burst below the surface, and had no effect, and that a large proportion of those at 3000 yds. did the same. The effect of percussion fuzes was very small.

OKEHAMPTON, 2. 9. 79.

Targets Employed, Infantry Formation in the Open.

1st Line.—112 half-dummies in two ranks, covering a front of 56 yds.
2nd Line.—120 yds. in rear, 11 6 × 3 targets, covering a front of about 30 yds.
3rd Line.—100 yds. in rear. The same.

Object.—To contrast shrapnel, time, and percussion.

Range, 2700 yds. :—

19 shrapnel shell, percussion fuze.

Results.

1st Line.—6 dummies hit by 10 bullets.
2nd Line.—3 " 9 "
3rd Line.—Nil.

15 shrapnel shell, time fuze.

1st Line.—22 dummies hit by 32 bullets.
2nd Line.—16 " 26 "
3rd Line.—13 " 16 "

Deductions.

At this range many of the shrapnel, percussion fuzes, again buried themselves. The result leaves little doubt of the superiority of time fuzes.

Targets Employed, Infantry in Formation in Open, the same as in last series.

Range, 350 yds. to first line.

12 rounds of case were fired, with 1° of elevation.

Results.

1st Line.—28 dummies disabled by 37 hits.
2nd Line.—26 throughs.
3rd Line.—6 "

General Remarks.

As may be seen from the practice table, the accuracy of the gun leaves little to be desired. Taking the results at the first series on the first day's practice as a fair test of what it can accomplish on service, the following table gives the results. They may certainly be looked upon as satisfactory. The range was 1800 yds., the target a gun detachment in the open. Out of the 32 rounds fired— Accuracy of gun.

7	were	range				Of these,	5	were in line.
15	"	within	20	yds.	of target...	"	12	"
3	"	"	40	"	...	"	3	"
5	"	"	60	"	...	"	3	"
2	"	"	80	"	...	"	1	"

As the vertical height due to 20 yds. over is a little under 6 ft., 22 rounds out of 32 would have hit a 6-ft. target.

When firing at a gun-pit, ten rounds of common shell, percussion fuzes, at 1500 yds., gave the following results:—Short 30 yds., 20 yds., 40 yds., parapet, parapet, 10 yds., parapet, 10 yds., 10 yds., parapet.

In the shelter-trench practice, at 1500 yds., 17 rounds struck the parapet out of a total of 25.

The competitive practice at 880 yds. with plugged shell gave the following results:—

Bull's-eyes	7
Hits, direct	23
" ricochet	2
Misses	8

Of the misses, one was due to the projectile having jammed in the bore, and consequent loss of range. The remainder, with two exceptions, were due to very small errors right or left; their elevation was correct.

During this practice Scott's sight was used, and no doubt contributed to the results obtained.

Accuracy of fuzes.

Out of 240 time fuzes, only 10 were blind, and of these only 4 could with certainty be said to be blind from any imperfection in the fuze. The other cases happened when firing at long ranges with a very small margin of length.

Out of 285 percussion fuzes only 4 gave no sign, but all were deeply buried, and there was not sufficient time to recover them to ascertain whether they were really blind or not.

The regularity of action of the time fuzes was most marked. When firing at targets having extended fronts, the following were the distances short at which it was supposed the best effects could be obtained, and which were therefore tried for:—

Under	1000 yds.	range	120 yds. short.
"	2000	"	100 "
"	3000	"	80 "
Over	3000	"	60 "

The following are a few of the results at 1200 yds., 28 rounds at a gun pit:—

	40 yds. short	5
40 to 60	"	6
60 to 80	"	9
80 to 100	"	5
Struck pit		2
Blind		1

The object having in this case small front and no depth, the distance of burst desired was about 70 yds. Range 1800 yds., at infantry formation. 30 rounds.

Under	30 yds.	6
30 to	60 "	4
60 to	80 "	7
80 to	110 "	8
110 to	150 "	4
Beyond		1
Blind		0

Distance desired, 110 yds.

Range 4000 yds. Targets representing cavalry front. 8 rounds.

30 yds.	short	2
70	"	1
80	"	3
100	"	1
120	"	1

Distance desired, 80 yds.

In this fuze those of the defects pointed out in a former paper ("Shrapnel Fire," "Proceedings, R.A.I.," Vol. X., No. 2) which were not inherent in the system have been remedied, and the result is as good a fuze as the system can produce. The excellence of its manufacture is beyond praise. But it still remains a fuze requiring considerable time and immense care in preparation, and which seriously impairs the efficiency of the shrapnel shell by the amount of space it requires.

Ammunition. The common shell, as far as these trials go, is not a success. So small a bursting charge as 10 ozs. of powder cannot possibly effect much; indeed it may be doubted whether gunpowder will ever prove efficient in any shell, small or large. In the small there is too little powder, and in the large the more powder the greater the set back and caking, and consequently the greater the loss of explosive power. The writer has watched many 64-pr. common shell fired at high angles fall on works; the heads were blown off, and the bases remained flaring for some second or two, till the caked powder was consumed. That the question of gun-cotton for the bursting charges of shells must sooner or later be seriously taken in hand, would seem a necessity.

Shrapnel. As regards the shrapnel, a new system is being now tried which must supersede the present pattern; it would be waste of time, therefore, to discuss their merits or demerits further.

Case. The power of the case is not satisfactory. It is little, if anything, superior to the 9-pr. M.L., and certainly not superior to that of the 16-pr. M.L. Undoubtedly this is almost entirely due to the size of the bullets (34 to the lb.) It is quite a question whether this weight is sufficient for shrapnel; for case it can hardly be enough. Case, from the necessity, or indeed possibility, of its use only arising in emergencies such as artillerymen hardly like to contemplate, or on chances which offer themselves so rarely, is a despised projectile—one about which no one troubles himself. Yet, even in its present form, it has at times done good service, and attained great successes. Undoubtedly it is capable of improvement, and if it could only be made effective up to 600 or 650 yds., as with such a gun as the present it surely might, its power would be far more than doubled. It would save many a commanding officer an anxious moment, prevent many a premature retirement, and encourage many to bold and decisive action when occasions, such as do at times present themselves with an enemy broken or retreating, gave an opportunity. For horse artillery, which from the very nature of its duties must at times expose itself to considerable risk when opening the attack, attempting sudden and forcible blows on

decisive points, or covering a retreat, and which has above all other arms the power, and therefore the obligation, of attacking and demoralising a retiring enemy at short ranges, such a projectile would be invaluable.

Carriages. Concerning the carriages little need be said. They are in principle nearly the same as those already in use, with the exception of the limber-boxes. Two points might, however, be touched upon. In the first place, they carry no rounds on the gun-carriage. Can this be right? In the present day, when, coming into action, the limbers must be retired as quickly as possible to shelter, it is almost impossible to get out ammunition till they halt, and thus much time is lost. This loss is not of course perceptible on field days, because a small cartridge, or if necessary two, can be served to a gun directly the trail is on the ground, quite irrespective of where the limber is or what it is doing; nor are limbers too often put in the positions which actual service would render imperative. On field days, therefore, guns are seldom or never left without ammunition at first coming into action. Again, in actual warfare limbers may necessarily be a long way off, and the service of ammunition then becomes a matter of great difficulty; nor does this occur in field days—a No. 6 can easily bring three rounds at a time. Sudden emergencies may frequently arise, and at a time, too, when the limbers may have had to retire temporarily; the guns are then either left without ammunition altogether, or moments are lost which, taken advantage of, might be the salvation of the battery; nor do these emergencies often occur in field day experience. The point seems thus to have escaped notice; I believe, however, that it is one of the first importance, and that no carriage can be called perfect —certainly not for horse artillery, where quickness is of importance— which does not carry *at least* two rounds of shrapnel and two of case in axletree-boxes.

In the second place, the carriage affords no protection to the detachment. Absolute protection is, I believe, impossible; but with the addition of a very small weight to the carriage, a breech-loading detachment could find fair cover—would, in a word, suffer only about 10 per cent. of the exposure which the men do at present from shrapnel or infantry fire, which are the only natures to be really feared. A very thin plating on the lids and fronts of the axletree-boxes (the former being raised in action), and the foot-rests being made of a plate instead of open as at present, would afford this seemingly incontestable advantage at a small cost in other respects.

ALDERSHOT,
February, 1880.

NOTE ON THE AMMUNITION EQUIPMENT OF ARTILLERY IN THE FIELD.

BY

COLONEL W. J. WILLIAMS, R.A., C.B.

(*Published in R.A. Institution Proceedings, No. 2, Vol. XI., p. 118.*)

ERRATA.—*For* "it would appear that 8 rounds of case, 32 rounds of common shell, and 108 rounds of shrapnel would be a better equipment than that which is now carried," *read* "it would appear that 8 rounds of case, 32 rounds of shrapnel, and 108 rounds of common shell, &c., &c."

RECENT EXPERIMENTS REGARDING THE BURSTING OF HEAVY GUNS.

A Lecture delivered at the R.A. Institution, on 18th March, 1880,

BY

CAPTAIN C. ORDE BROWNE,

Late Royal Artillery.

My aim this afternoon is to sketch briefly the general features of the subjects specified in the title of this paper. The *experiments* referred to were of a public character, and through the kindness of the heads of departments, General Gordon, and Sir W. Palliser, I have had every opportunity of obtaining information.

The subjects to be thus noticed are—

1. The "Thunderer" gun accident.
2. The "Thunderer" gun experiment.
3. The Palliser gun experiment.
4. The Krupp gun accident.
5. The Armstrong 100-ton gun accident.

As the "Thunderer" gun experiment was intended to be a reproduction of the accident to its turret companion, a few words must be devoted to the accident before the experiment is spoken of.

1. "Thunderer" Gun Accident.

The accident was briefly as follows:—

On January 2nd, 1879, the "Thunderer" was engaged in target practice. An electric broadside had just been fired, when the two 38-ton guns in the fore turret had been loaded with 110-lb. charges of P. powder and Palliser projectiles weighing 688 lbs. They were now loaded with 85 lbs. of P. powder, and common shells of 575 lbs. The order was then given to fire the guns independently, "turret on the move." The right gun of the fore turret fired at the target at 1000 yds. Two or three minutes afterwards the left gun was fired at the same range, when it burst explosively, destroying the top of the turret; the gas also rushed into the shell-room and engine-room, knocking down the stokers and extinguishing all lights; bulkheads were destroyed, and the deck damaged. Out of 10 men in the turret, 8 were instantly killed, 1 died after 2 days, and 1, though severely

wounded, lived. 2 men were killed and 35 wounded on the battery deck. The gun had been loaded by the Elswick hydraulic machinery, and wads had been employed.

A Committee, of which Admiral Luard was President, took evidence as to the cause of this accident, and eventually came unanimously to the following conclusion:—That in the electric broadside the gun had missed fire, and had been run back by the hydraulic gear and loaded with charge and common shell on the top of the charge and Palliser shot already in the bore; that the absence of recoil when the gun missed fire escaped notice, the gun being at once run fully back by the hydraulic gear; while the action of the telescopic rammer inside the bore of the gun was not of such a character as to betray the presence of the second charge and shot.

The most important evidence given on the subject was that of Captain Andrew Noble. He considered that the following circumstances pointed to the conclusion adopted by the Committee:—

1st. *The evidence of great pressure,* exhibited by the expansion of the bore near the point of rupture; and the marks of violence to be seen on the hydraulic gear, which show that a recoil of an extraordinary kind took place.

2nd. *The position of the fracture,* which accorded with what he should expect from the explosion of two charges under the conditions arising from double loading.

3rd. Certain indications in the bore—namely, the marks of abrasion of shot made *after the displacement of the steel tube fragments,* while no marks of jamming or seizure are to be found in the parts of the barrel recovered.

Captain Noble further suggested the special examination of the recovered studs. These being examined in the Royal Laboratory, one was pronounced unquestionably to be that of a Palliser projectile: the marks indicating the nature of the studs are such as can be perceived by anyone with the help of a magnifying glass.

With regard to other hypotheses, Captain Noble argued from indications of the fractured tube that it had given way all at once, not gradually. For example, the fact that the parts of the tube between the cracks were much extended pointed to this conclusion. He did not think it possible that the shot had been checked by a wad wedging; wooden wedge wads have long been in use, and have never been known to have this effect.

Captain Noble sent in a diagram showing the pressures on different parts of the bore with charges of 85, 110, and 200 lbs. of powder. He calculated that the gun at the point of rupture was capable of withstanding a pressure of 17·4 tons on the square inch. If the steel tube were ruptured, it would still bear 7·8 tons, and the two outside coils at the overlap—that is supposing the gas got so far—would even then bear 4·3 tons. It is possible that these calculated resistances might not represent the strength of the individual gun within 50 per cent., but the gun would have at least the above strength.

With an 85-lb. charge the pressure at 6½ ft. from bottom of bore should not exceed 5½ tons, and Captain Noble believed that if the projectile were immovably fixed with its base there, and the charge fired, the gun would resist the strain. A shell in motion suddenly checked would throw a great strain on the gun (Answer No. 484), but he considered the wad wholly inadequate so to check it.

The diagram here shown is Captain Noble's. It is intended to suggest the process of fracture. He considered that certain splinters show marks of having been tilted in the form of a cone whose base was towards the muzzle, and of having in this position been grazed by the passage of a projectile over their hinder ends. This he could only account for on the supposition of a charge opening them in front of a projectile—that is, on the supposition that the gun was double loaded.

Many of us thought that wedging was the probable cause of the accident before we received the report of the Committee. The gas-check unquestionably increases the danger of such an occurrence; for it prevents the imprisoned gas from rushing in any considerable quantity past the projectile, and so finding a safety valve. The idea that an air-space formed by the projectile slipping in the bore was the cause of the explosion was dismissed soon, but it constituted the third subject to be investigated by the Committee of which General Gordon is President.

The opinion in favour of wedging which deserves most attention is that of Sir William Palliser. He urges that in crushing a wad at the very high velocity at which the projectile is moving, a sufficient resistance may be offered to jam the shot, and so to burst the gun, and that he has made experiments proving that this result

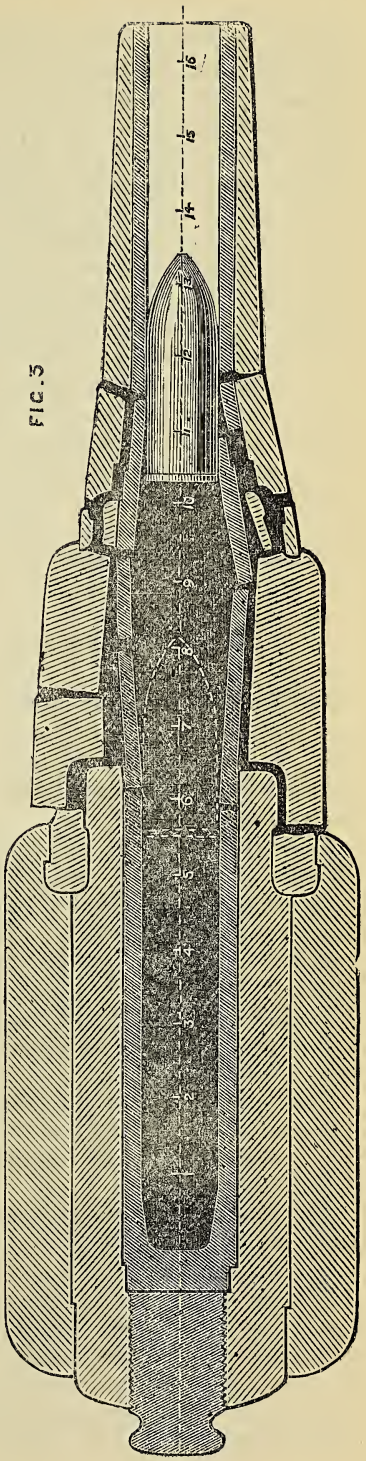


FIG. 3

will be arrived at in a considerable percentage of instances (about 20 per cent.); also that the marks of violence in such a case would be further forward than in the case of a burst from double loading. This he considers agrees with the marks in the first "Thunderer" gun, which show evidence of outward pressure at from 90 to 96 ins. from the bottom of the bore, in front of the seat of the front charge. It is fair to point out that Captain Noble indicates this position. (See Fig. 3, p. 179). Probably most of us have great difficulty in believing that the milled-board wad could so act as a wedge; also Sir W. Palliser's objection to the identification of the stud appears untenable, and his argument against the probability of the Palliser projectile breaking up is answered by the fact that the second projectile actually did so break. On the other hand, it is a little difficult at first to take the conception of the charge being moved bodily forward so as to exert its maximum effect at a point in advance of its front end. It would argue that the charge was set up and acted on by flash rather more slowly than we might have expected. Captain Noble's mastery of the subject is itself so evident, and his evidence so strong, that probably few of us fail to accept his conclusions.

2. "Thunderer" Gun Experiment.

The turret companion of the gun which burst being exactly similar—that is to say, being a 38-ton gun with a 12-in. bore, taking the ammunition, therefore, of the 35-ton gun—was mounted in the Royal Arsenal, and tested with a view to investigate the nature of the "Thunderer" gun accident.

The first series of tests was with reference to air-space. These proved that as the air-space between cartridge and projectile increased, the pressure diminished. It soon appeared a mere waste of powder to continue the investigation. The recoil of the gun did not decrease in proportion to the projectile, which, under the circumstances, was to be expected. When the space reached 10 ft., the pressure on the bore had diminished to 0·5 tons, and the recoil to 1 ft. 6 ins. With a pressure of 21·8 tons the recoil had only been 4 ft. 1 in.

Wads wedging.—On January 16 (No. 15 of series), charge 85 lbs., and common shell 592 lbs., wad placed 5 ft. in front of shell, tilted to 45°, wad crushed, p. 20·7 tons on bore, $v = 1409$, pressure on base of shell 17·6 tons.

2nd Round.—Same, but wad placed fair at 5 ft. to test splitting; p. 20 and 16·5, $v = 1422$.

Of course two rounds could not test the liability of an occurrence that was only stated to take place once in five rounds, but the behaviour of the wads was such that the Committee were satisfied that this *kind of wad could* not jam a shell in *this gun*. Sir W. Palliser's results with other guns and wads did not therefore concern them.

On *Tuesday, Feb. 3rd,* last the experiment on double loading took

place. The 38-ton gun taken from the "Thunderer" was loaded in the Arsenal in the same way as its fellow which burst on board ship, supposing the latter to have failed to fire at the electric discharge; that is to say, the second gun was double-loaded in the following way:—First, with a 110-lb. battering charge of pebble powder, and a 688-lb. Palliser projectile and wad; then over that with an 85-lb. charge, and 575-lb. common shell and wad; and in this condition it was fired, pressure gauges being employed on the base of each projectile and in the bottom of the bore.

The gun so fired burst in front of the trunnions, very near the same spot as its fellow. A general resemblance, however, might be due to the fact that both guns, in common with other Fraser guns of the same type, are very strong about the breech; so that any strain suddenly brought upon the piece when the projectile was some distance forward might so far resemble the action of a charge fired in an advanced position that the gun might yield in both cases at its weaker part. Evidence, then, is needed to identify the two burst guns as exactly as possible in detail. The principal points of the material evidence on which the conclusion of the Committee appears to be chiefly based are the following:—(1) The indication of great pressure; (2) the position of the fracture; (3) certain indications in the form of abrasions of a projectile in the bore; (4) evidence furnished by a stud picked up in the turret. Let us consider these in detail, and see whether a close and convincing correspondence in the case of both guns is to be found.

(1) *In the Steel Tube.*—An indication of great pressure cannot possibly fail to be found in the case of the Arsenal experiments; the question is whether in its nature it corresponds to that in the gun burst on service:—(*a*) The maximum expansion of the powder-chamber in the first gun was about 0·033 in.; in the second gun the expansion at 2 ft. 6 ins. from the bottom of the bore was ·004 in. horizontally and ·006 in. vertically. (*b*) The maximum expansion is at 5 ft., where it is ·093 in. horizontally and ·088 in. vertically; the tube of the first gun at from 30 ins. to 54 ins. from the bottom of the bore is in an ordinary state, but from 54 ins. to the fracture—at about 72 ins.—it is bell-mouthed, the diameter increasing until nearly six-tenths of an inch is reached at the edge of the fracture; the expansion is nearly all in the grooves, which are widened in some parts two-tenths of an inch. The second gun is incapable of measurement at 72 ins., being broken off short of that point. A precise comparison of the above is impossible, because the expansions in the first gun are taken with reference to original dimensions, while those in the second gun are due to this one round. In both cases there is a bell-mouthed or conical enlargement which corresponds as fully as could be expected. (*c*) At a point 69 ins. from the bottom of bore of the first gun is a smooth mark for 6 ins. near the lowest portion of the circle where the projectile was pressed. The interior of the barrel of the second gun cannot be examined as to this at present, being built on to a wood spindle. (*d*) Two longitudinal cracks in the first gun run from point of rupture for a foot to the rear, and then transversely.

Two longitudinal cracks in the second gun run from point of rupture; one starts at top, takes a spiral direction, and ends at "down," nearly opposite the vent; the other runs longitudinally for about 2 ft. The general direction of cracks in both cases corresponds, but the second gun has suffered decidedly more than the first. (*e*) There is no appearance of jamming or seizure on the slot of the bore of the first gun, but grooves widened for 18 ins. from point of rupture. The second gun agrees generally with this for the length corresponding to the portion left of the first gun; at 10 ft. 7½ ins., however, commences a series of violent abrasions, which continue for about 3½ ft., ending with a tremendous scoop, where steel is scraped off, and the muzzle part of the tube for about 2 ft. 5 ins. broken off entire.

In the first gun are three pieces of barrel about the bottom of the circle, at about 6 ft. from the bottom of the bore, showing marks indicating that the projectile was passing over them when rupture took place; and at from 9 ft. 7 ins., 10 ft. 6 ins., and 11 ft. and 11 ft. 9 ins. are four or five marks of striking from the projectile. No portion of the steel tube is recovered beyond 12 ft. 2 ins. from the bottom of the bore. The most striking marks begin about where the steel barrel becomes its minimum thickness, and run on from there—that is, at about 10 ft. 6 ins. from the bottom of the bore. Here, then, is all the correspondence that could be reasonably looked for.

Next, *as to resemblance in the fracture of the exterior coils.* Figs. 1 and 2 give the horizontal projection of the guns, looking down on them, and Figs. 3 and 4 give the guns turned over so as to show the under sides. The parts shaded flat in 1 and 3 are deficient, owing to the fragments having gone overboard. Figs. 2 and 4 appear to be broken into smaller pieces, but if the fragments corresponding to those lost in 1 and 8 be shaded and left for after consideration, the comparison of the action of the two guns can be better made, and a close resemblance may be traced in the manner of breaking up. To commence at the breech, the second gun's *C* coil is cracked in a longitudinal line (shown in Fig. 4), also there is a ring fracture running round nearly the entire circumference in front of the trunnions, which fractures are not found on the first gun, but there is on that a ring fracture within a foot of the same place, running completely round the "1 *B* coil." There is, then, a measure of similarity in the guns having parted in a ring fracture near the same place—that is, nearly at the place where the *B* and *C* coils hook on to each other. In one case the *C* coil has yielded and the *B* has stood; in the other the *B* has yielded and the *C* has stood. In this, of course, is a distinct difference. The *C* coil ought to be the stronger; still, if from any cause it should be the weaker of the two, the same strain on a gun which might ordinarily tear the *B* coil might then find relief in tearing the *C* in preference. There is, of course, the alternative suggestion that the pressure took place further forward in the first gun than in the second one. This, indeed, is the main point on which Sir William Palliser argues that the first gun was not burst from the same cause as the second. The effect on the breech portion of the second gun was undoubtedly greater, as shown by the longitudinal cracks, and the position of the ring fracture was further back. Admitting these features,

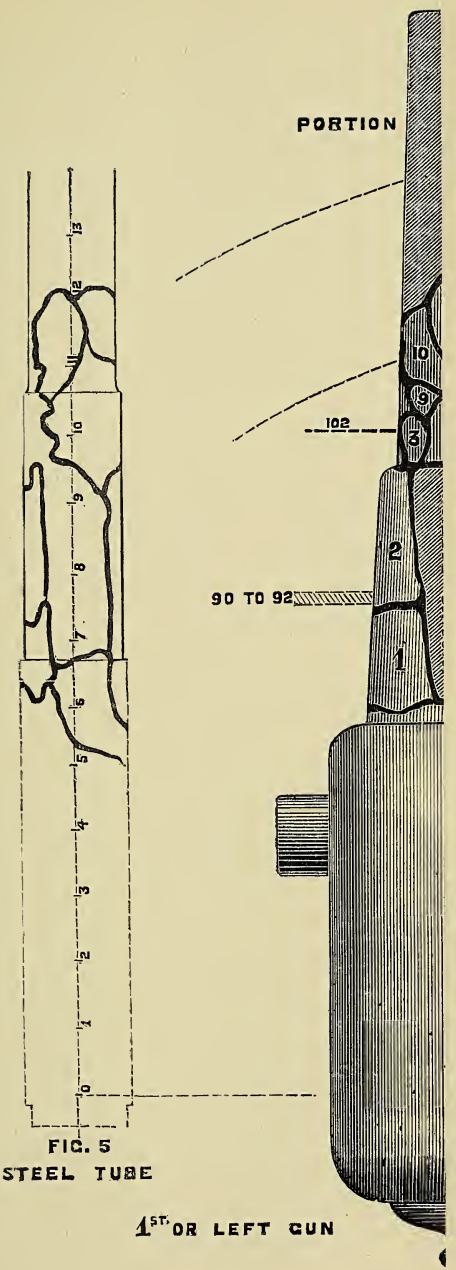


FIG. 5
STEEL TUBE

1ST. OR LEFT GUN

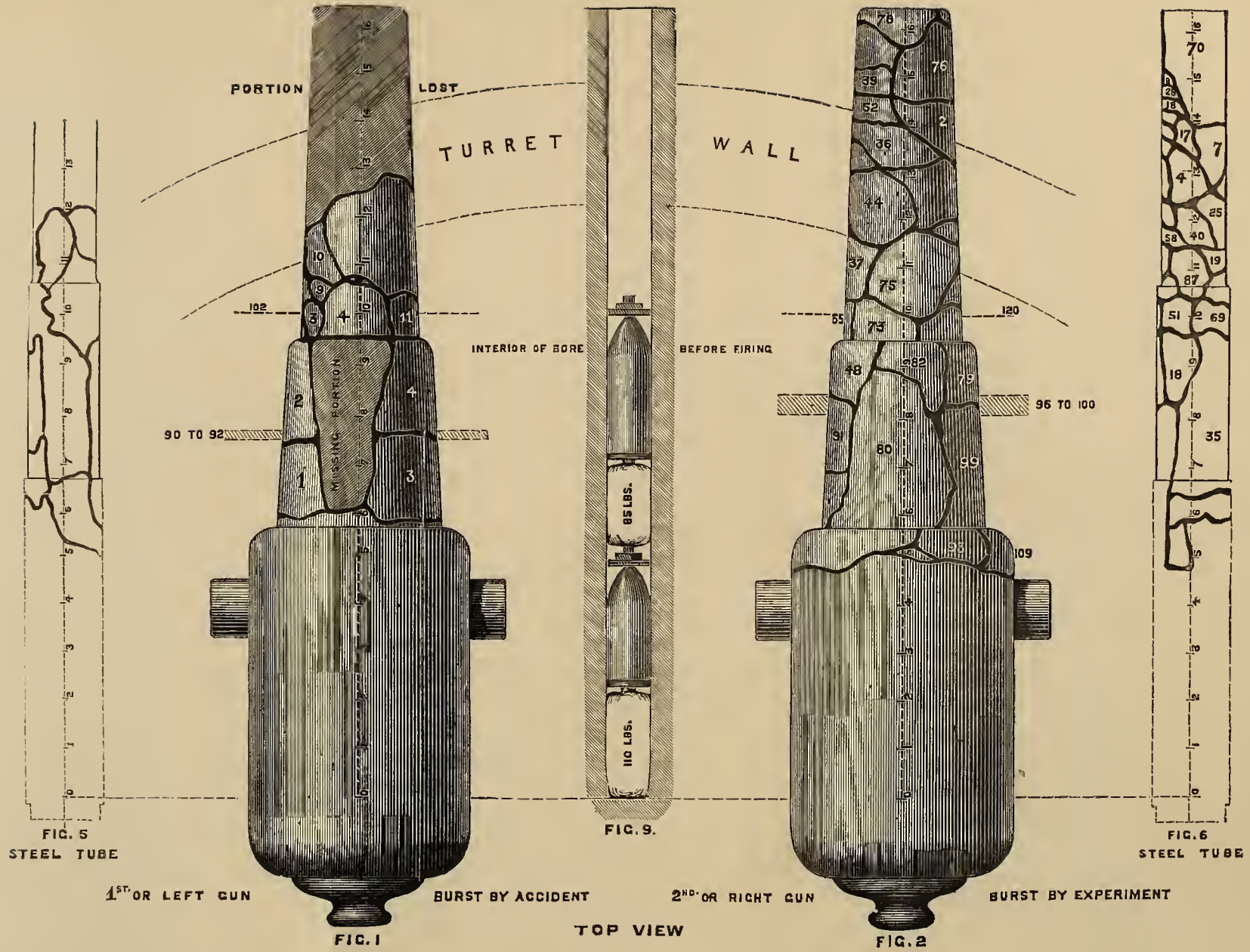


FIG. 5
STEEL TUBE

FIG. 9.

FIG. 6
STEEL TUBE

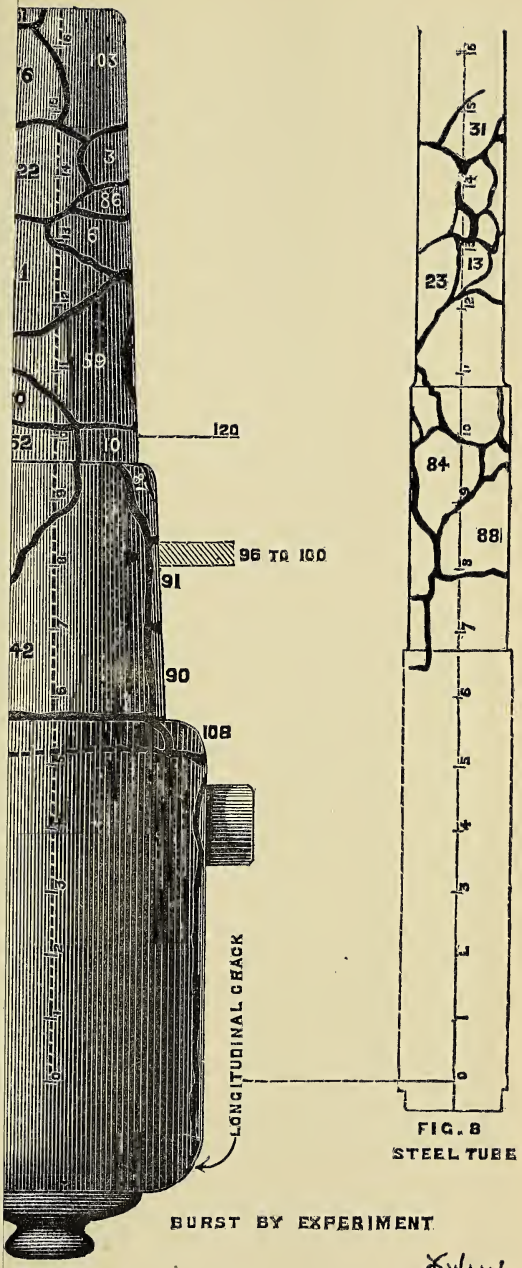
1ST. OR LEFT GUN BURST BY ACCIDENT

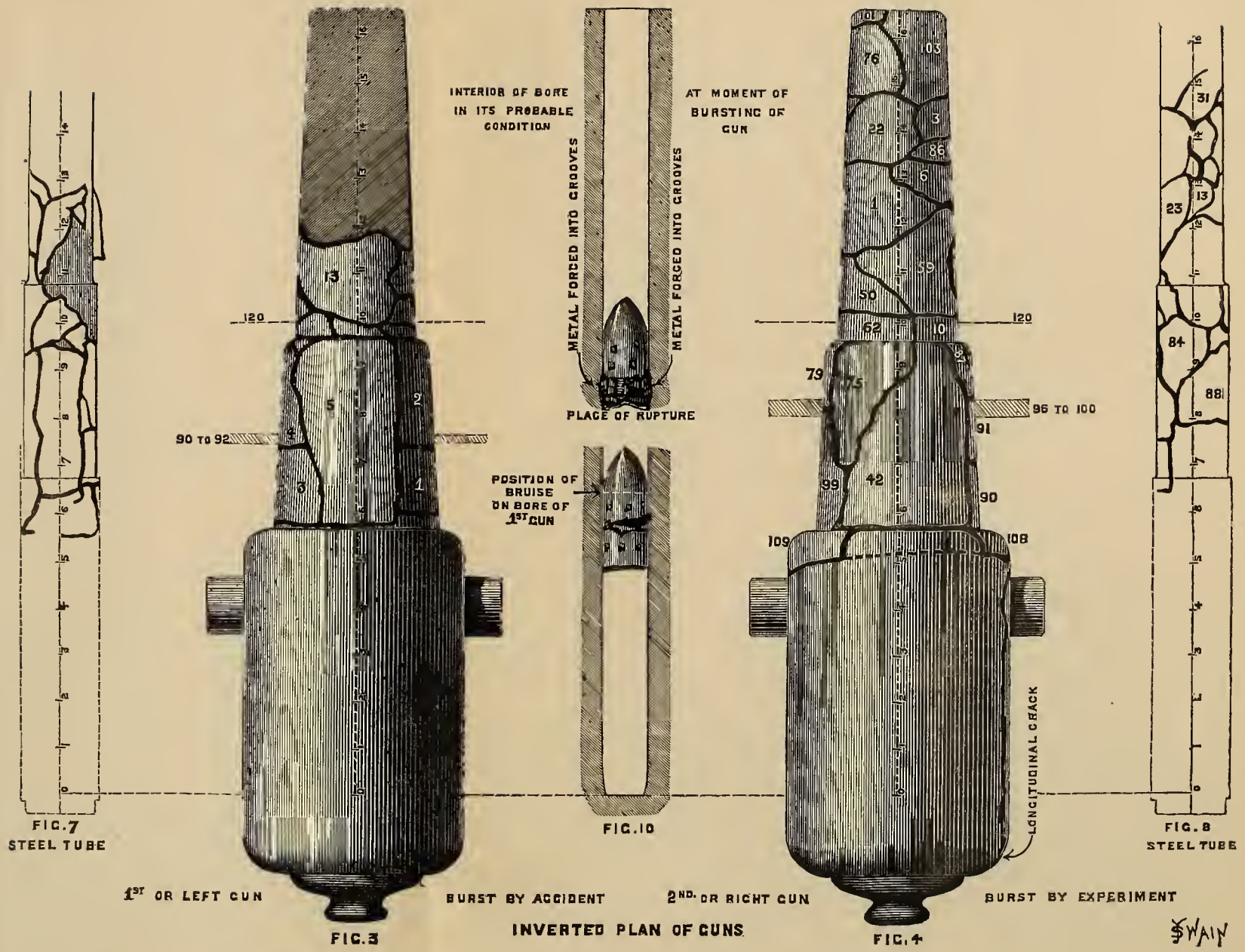
FIG. 1

TOP VIEW

2ND. OR RIGHT GUN BURST BY EXPERIMENT

FIG. 2


103
3
6
59
10
120
96 TO 100
91
90
108
LONGITUDINAL CRACK
31
13
23
84
88
FIG. 8
STEEL TUBE
BURST BY EXPERIMENT
FIG. 4
SWAIN


INTERIOR OF BORE IN ITS PROBABLE CONDITION
AT MOMENT OF BURSTING OF GUN
METAL FORCED INTO GROOVES
METAL FORCED INTO GROOVES
PLACE OF RUPTURE
POSITION OF BRUISE ON BORE OF 1ST GUN
120
90 TO 92
96 TO 100
LONGITUDINAL CRACK
FIG. 7 STEEL TUBE
FIG. 3
FIG. 10
FIG. 4
FIG. 8 STEEL TUBE
1ST OR LEFT GUN
BURST BY ACCIDENT
2ND. OR RIGHT GUN
BURST BY EXPERIMENT
INVERTED PLAN OF GUNS
SWAIN

however, it is to be considered whether the difference may not be due to the accidental fact that the same force might find the line of least resistance, as we have said, in the *C* coil hook, in preference to that of the *B* coil; or whether the same cause—namely, the explosion caused by double loading—might not be sufficiently irregular in its development to account for such a variation in position of fracture. I adopt one of these alternative explanations in preference to that of Sir William Palliser, because the evidence on other points appears to me overwhelming; but I wish to state the difference on which Sir William Palliser argues fully. In fact, in Fig. 4 I have rather drawn the longitudinal crack more distinct than the exact projection in such a position close over the trunnion would justify, in order to exhibit it distinctly.

Next *to pass on to the* B *coil.* As I have just noticed, there is a ring fracture close to the edge of the *C* coil in the first gun (Figs. 1 and 3) which does not exist in the second (Figs. 2 and 4), because the yielding of the edge *C* coil in the latter gun left the *B* coil free to escape entire at that edge.

In the first gun there is a ring fracture extending the greater part of the circumference at from 90 ins. to 92 ins. from the bottom of the bore. The interruptions are caused by the missing fragment (*vide* Fig. 1), and the No. 5 piece, extending for the entire length of the coil at the bottom (*vide* Fig. 3).

In the second gun there is a ring fracture extending a great part of the way round, about 96 ins. to 100 ins. from the bottom of the bore broken by fragment 80, nearly corresponding to the missing fragment in the first gun, and by 75 and 42 (*vide* Fig. 4), nearly corresponding with fragment 5 in first gun (Fig. 3).

Here is a marked similarity, a ring fracture broken in each case by an entire end-to-end fragment below; and while it is going too far to argue that the missing portion escaped in a single fragment—which might appear probable, or the hinder half might probably have been left on board—at all events no want of similarity ought to be argued on the opposite assumption. Observe also that in this case the ring in the second gun is rather in advance instead of behind that in the first.

In the B *tube* we are at once met with a very striking resemblance in the fact that a complete ring fracture is found at from 120 ins. to 124 ins. from the bottom of the bore in both guns, strikingly similar in character, both fractures being very straight in the underneath half of the gun (*vide* Figs. 3 and 4), and more zigzag above (*vide* Figs. 1 and 2). In front of this the first gun has no distinct ring fracture up to the edge of the portion lost overboard. The second gun is the same in the general character of its fragments up to the corresponding distance. There is much breaking up of the muzzle portion; but no comparison can be made in this respect with the other gun, because all the corresponding portions are lost.

The steel tubes are shown on each side of the entire guns (*vide* Figs. 5, 6, 7, and 8), and correspond obviously to a certain extent with the outer casing of the guns in their lines of fracture.

The correspondence, on the whole, between the lines of fracture of

the two guns is as close as could be expected when such an agent as powder is employed. The absolute identification of the stud of the Palliser projectile, in the case of the first gun, in my mind alone settles the question, coupled with the fact that Sir W. Palliser wrote, on December 13th last, that he considered it improbable that the Palliser projectile would break in a case of double loading, whereas, when the second gun was fired, the Palliser projectile did so break up.

This brings us to the consideration of the *evidence obtained in the case of the second gun, which cannot be compared with anything in the first gun, because founded on data which depend on material lost in the first case.* This evidence I consider explanatory of the behaviour of the second gun, and to a certain extent throwing light on features which exist alike in both guns which were held to militate against the conclusion of the Committee that the first gun was double loaded, but which might equally have argued against double loading being the cause of bursting in the second gun, had the cause in that case been a matter of subsequent conjecture instead of observation.

I have already spoken of the main ground for arguing against double loading—namely, the fracture of the gun in a position rather in advance of the supposed seat of maximum pressure. Captain Noble, in his evidence (Answer No. 496) stated that he considered that the most violent pressure had acted on the posterior half of the *B* coil, extending from about 6 ft. to 8 ft. from the bottom of the bore, which would be opposite the front part of the front charge—that is, the place of maximum pressure found by Sir W. Palliser in his double-loading experiments. Nevertheless the gun yielded, as may be seen in the figures, mainly at the ring fracture at 90 ins. from the bottom of the bore, which is only 6 ins. from the front limit of the region defined by Captain Noble; and his drawing of the bursting apparently agrees with this better than with a more backward position.

In the second gun this general line of fracture is certainly as far forward. (*Vide* Figs. 2, 4, and 8). This would be rather in advance of the front of the front charge, which does not quite accord with Sir W. Palliser's experiment, which in five rounds gave a maximum effect opposite the front portion of the front charge, but hardly up to the front edge of it, and a decreased effect beyond this limit. In cases of single loading, the maximum pressure is said to have occurred even beyond the front of the single charge; but the front charge in double loading is fired in a violent and exceptional manner, and Sir W. Palliser's experiments being on double loading, seem the natural ones to refer to. Without, therefore, saying that there is any great discrepancy—certainly not one to shake my belief in the fact of both guns being double loaded, especially as this feature is common to both—it may be well to see if there is any evidence existing in the case of the second gun to account for a more forward action than might be expected. The materials at hand are the broken projectiles and gauges, and the front portions of the barrel.

The condition of the projectiles speaks for itself.* The common shell

* The fragments of the common shell were exhibited at the lecture.

has had its bottom broken up, and the circle of fragments adjacent to it have been, you observe, driven forward so as to be violently scored and wedged by anterior portions of the shell, and forced outwards so as to have the iron pressed into the grooves of the gun and actually moulded to them. Obviously the bore *must have been intact while the iron was being thus moulded to it. The scoring of the interior evidently was at the same time so violent, and also so symmetrical, that it must have been done while the projectile was still held in the bore.* The tool marks round the shell's exterior, including the portions forced into the grooves, are so clear and sharp that, as has been pointed out by Colonel Maitland, they could not have been subject to violent rubbing along the bore. In other words, *the gun must have yielded just as the shell was set up and wedged into the grooves.* The marks of great violence and wedging on so many parts of the common shell argue the probability of a tremendous shock being given to the gun. Does it not appear probable, then, that the bottom of the common shell *was shivered comparatively easily,* and that the full shock fell on the gun as the broken shell set up and wedged in the bore ? This might easily explain a more forward fracture than would occur with solid shot, when the front projectile would give its full resistance at once, and then move forward intact. There is one very curious fact to be noticed here—namely, that the *choke of the front cartridge was picked up unconsumed in the head of the common shell.* This, then, *was driven up into the interior of the latter before the gas could consume it; indicating how immediate was the breaking in of the base of the common shell.* When once wedged among metal fragments it might easily escape consumption, as anyone will admit who knows how large a hole must be drilled in the base of a shell to allow a flash to enter the interior. This might justify the difficulty originally felt by some at the forward position of the burst. At the same time it would show that Sir W. Palliser's experiments, whatever they might teach, would not fully represent the case of double loading with a shell in front of a shot. Were I to draw a figure at the moment of bursting now, I should show the front of the common shell (*vide* Fig. 10) in its position when rammed home, and the rear of it broken and jammed up so as to be somewhere from 90 ins. to 96 ins. from the bottom of the bore. The Palliser projectile would have moved some distance forward. Finally, pending the discovery of indications on this portion of the second gun, which is not now open to examination, I should place the front part of the body next the head, which is of the full diameter, at 69 ins. from the bottom of the bore; because at that spot in the first gun was found a bright pressure mark extending for 6 ins., apparently made by the body of the projectile being forced against it. This would bring the point to about 84 ins. from the bottom of the bore, and within about 2 ins. of the original position of the front projectile, and about 10 ins., or rather more, from the bottom as now driven up. At the moment of explosion doubtless the chilled projectile broke across, and I think that at this moment all its studs were sheared. A portion of a stud is left, but not, I think, more than might be due to the windage enabling the roots of the stud to escape the shearing by the uppermost groove. With this exception the studs are symmetrically sheared, and therefore, I believe, sheared in the bore.

As to the marks on the front part of the bore, I lay little stress on them, because the state of things was such that violent scoring and fracture might be expected, and that of an irregular character. We have a common shell broken and wedged up in front of a charge fired with sudden and exceptional violence, then a Palliser shell broken across with its stud sheared, and a battering charge in explosion behind it. With this going on the gun would arrive at a state of dissolution too advanced to be subject to rule. The front fractures may be striking, then, as the exhibition of physical force, but I question if much instruction is to be obtained from them, except perhaps the indications that the bore was broken up partly by the action of the projectiles in its interior, and not only by the force of powder. For example, the steel bore is specially scored and cut and distorted by fragments from 10 ft. 6 ins. from the bottom of the bore to within about 2 ft. of the muzzle, and this is the part of the gun which is broken up into the smallest fragments.

To sum up, we ought to wait for the Committee's report for a final opinion, but I submit the above comparison of the evidence before it with confidence that reasonable minds will conclude that the two guns were burst in the same way. The breech portion of the second gun yielded more than that of the first, but little ground will be found on which to found a distinction in character between the two. The identification of the Palliser stud, and the breaking up of the Palliser projectile in the second gun are all in accordance with the conclusion of the Malta Committee, and against an opposite explanation. The evidence furnished by the projectiles recovered in the Arsenal experiment seems to give a reasonable, if not an unanswerable explanation of the fact of the pressure being exerted on the gun in a rather more forward position than might have been expected, and than was actually obtained by Sir William Palliser in double loading with solid projectiles.

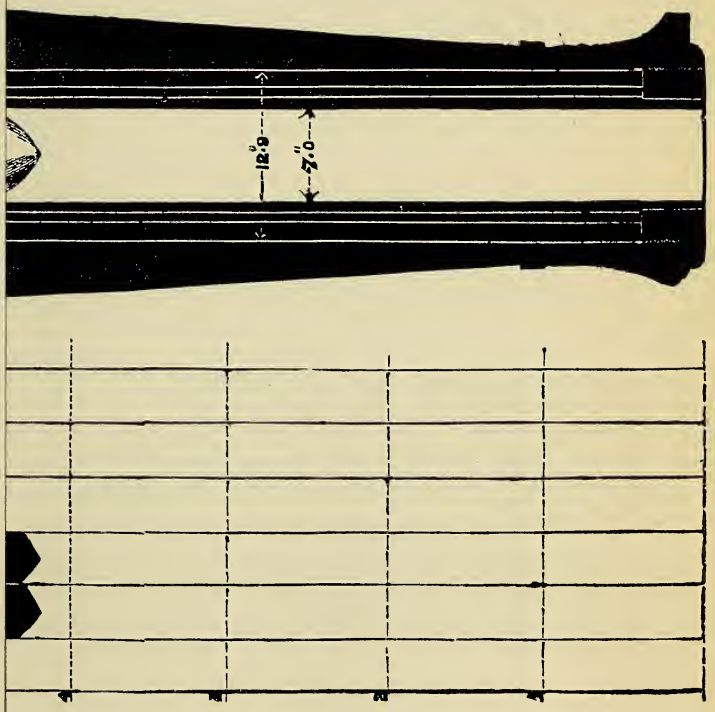
Finally, the agreement of the zone of most numerous lines of fracture in the exterior of the gun with that of greatest abrasion from projectiles in the steel tube seems to show that the gun was broken up, in a measure, from the action of an aggravated form of violence from the wedging of fragments which would not occur under any ordinary circumstances.

3. The Palliser Gun Experiment.

Sir W. Palliser carried out an enterprising programme of experiments on double loading at Erith on Wednesday, March 3rd, his object being, as he expresses it, "to ascertain the ultimate strength of a gun lined with a coiled barrel 7 ins. in bore and barely 3 ins. thick, and in the event of the gun bursting, to see whether or not it explodes with violence." It is natural to ask the question whether this experiment is connected with the recent trials of the "Thunderer" gun, and whether its results are intended to bear either upon the question of how that gun burst, or upon the relative powers of Woolwich guns proper and Palliser guns. The object, as stated by Sir W. Palliser, necessarily connects itself with the last-named point;

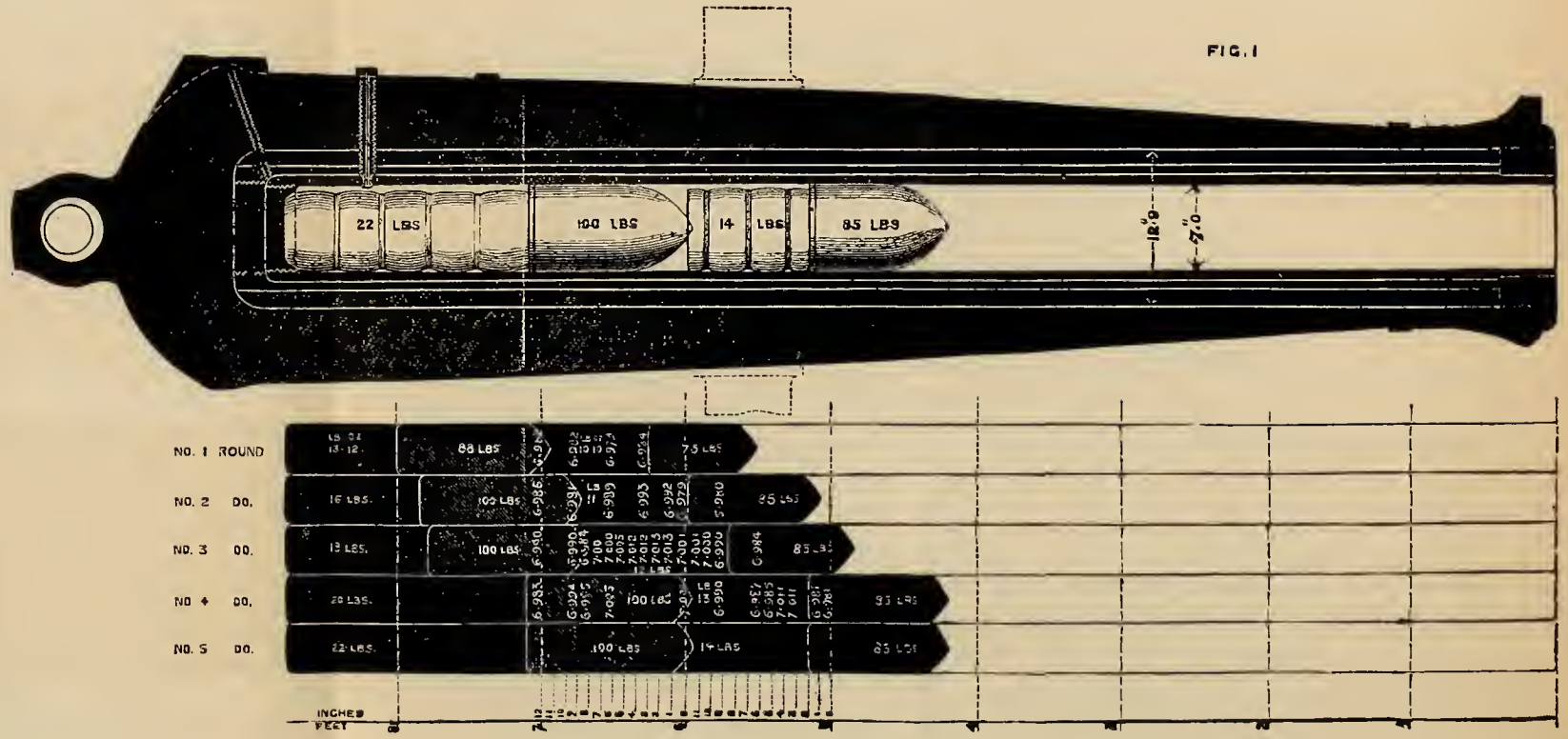
IENTS.

FIG. I



PALLISER GUN EXPERIMENTS.

FIG. I



for if it is shown that the ultimate strength of a coiled inner barrel is greater than that of a steel tube, and that such a barrel yields gradually, it gives support to Sir W. Palliser's steady advocacy of coiled iron. Its bearing upon the cause of the bursting of the "Thunderer" gun is less apparent, but we believe that Sir W. Palliser would trace the connection in the following way:—He holds that the mischievous strain falls on the gun exactly at the seat of the front charge of a double-loaded gun, and that a gun burst simply by double loading would yield at this place. He admits, of course, that the gun recently burst at Woolwich was burst by double loading, but he considers that its turret companion gave way at a point further forward; consequently I believe that he is not yet satisfied that double loading was the real cause of its destruction. The Erith experiments, so far as they may be found to localise the exact position of the strain, would so, he would consider, bear out his opinion. Shortly, then, it would be Sir W. Palliser's wish that the gun to be tried should bear a great strain; should ultimately yield gradually, giving notice of its yielding; and lastly, should furnish evidence that the strain falls chiefly on the precise spot where the front charge is situated.

The gun tried was a 7-in. rifled gun of 95 cwt., converted from a 10-in. shell-gun of 84 cwt. by means of a coiled wrought-iron barrel. The piece was a veteran, the shell or outer casing of it being a 10-in. gun which had been fired in the trenches at Sebastopol in 1855. I suppose it must have been one of two 10-in. guns mounted rather late in the siege, which did good work against the left face of the "Great Redan." This gun had been struck and cut by shell in the muzzle. From a sentimental point of view, it was melancholy to witness its vivisection in its old age.

The strength of the piece, of course, depended on its inner tubes, which also had a history. There were three of them, as shown in Fig. 1. The outer of the three had been placed originally in a 68-pr. gun of 95 cwt., with a steel tube inside it. The steel tube had split in firing, and had been bored out, and the second coil had been inserted, giving a calibre of 7 ins. The 68-pr. gun thus lined had been severely tested in various ways—I might almost say tested to destruction, the breech blowing out at the 136th round. The double coil had then been removed and entered as a lining to the 10-in. gun employed in this trial, the chase being at first bored out to a diameter of 8 ins. and rifled. In this condition, weighing in all $4\frac{1}{2}$ tons, it was tested very severely at Shoeburyness, in consequence of a gun with a steel lining having given way; being not only subjected to the proof-firing of a 9-ton gun, but shells fired with air-spaces and made to burst in the bore. The coils bulged, but did not burst. The gun then went to Newcastle, and a new vent was drilled, and it was fired at Ridsdale—ten rounds with 30 lbs. of R.L.G. powder and 180-lb. projectiles. Next it was bored up to $8\frac{1}{2}$ ins., and lined with a third tube 0·75 in. thick, bringing the calibre to 7 ins. In this state it was rifled, and fired two rounds with $27\frac{1}{2}$ lbs. of powder and with a 115-lb. shot.

This gun, then, has performed very hard service indeed, with the

exception of the inner coiled tube. It weighs 95 cwt. Sir W. Palliser proposed to fire five rounds in succession from it, unless the gun gave way during the trial; pebble powder to be used throughout. He fixed the weights of powder and shot of the first round on a principle of proportion to the 38-ton gun ammunition—that is, 95 cwt. being one-eighth of 38 tons, he considered that ammunition weighing one-eighth the amount of that fired in the latter gun would throw a similar strain on the former. It will be seen that 110 lbs. and 85 lbs. are eight times 13 lbs. 12 ozs. and 10 lbs. 10 ozs. respectively, while 688 lbs. and 575 lbs. are not so much as eight times as great as 88 lbs. and 77 lbs.; consequently, if Sir W. Palliser's theory is correct, he would not be doing his own gun full justice. Probably artillerists generally would not be prepared to admit his theory, however, for a moment. It seems ungracious to cavil at the conditions of so really audacious an experiment. There can be no question that the programme was very severe, and that Sir W. Palliser showed great confidence in his gun to undertake it; but to benefit by it, it is necessary to analyse carefully, and I must begin by pointing out that there is considerable difficulty in ascertaining the strain really incurred by the gun. Pebble powder gives a much less strain on a small gun than a larger. To carry proportions out fully, the grains should have been much smaller, though I am not prepared to say that one-eighth the size would have been the proper dimension. I have before observed that I do not think it fair to expect Sir W. Palliser to use R.L.G. powder—as has been suggested—merely because it would be more severe, or because it was at one time the service powder for guns of this size. I believe, however, that it was very desirable to use pressure gauges in the gun, in order to get the full benefit of the experiment and satisfy objections. That objections to making a comparison between powder results irrespective of size of grain are not frivolous, may be seen from the fact that nearly equal charges of pebble and R.L.G. powder in a 64-pr. gun have given about 5 tons and 25 tons pressure respectively. On Sir W. Palliser's side it may be mentioned that the service battering charge for the Woolwich 7-in. gun now consists of "30 lbs. of pebble powder, or 22 lbs. of R.L.G. powder," which furnishes an orthodox scale of comparison between the effect of these two classes of powder in a 7-in. bore (*vide* the Official Laboratory Treatise on Ammunition); so that it may be urged that pebble powder is a recognised class of powder for a 7-in. gun, and that the pressure may be probably well known and registered in the Royal Arsenal.

Sir W. Palliser contemplated the use of pressure gauges, and borrowed some from the Arsenal with a view to supplying suitable gauges for the case before us, but concluded that to enter them in the breech would weaken it, and a gauge there, or in rear of the rear projectile, would not give the pressure at the most important place, while a gauge in the base of the front projectile would, he considered, be destroyed by impact of the point of the rear projectile. I regret this decision, because I believe that the point of the rear projectile would not strike the base of the front one, at all events when the

charge between them became considerable; and this is when the pressure becomes greatest, and its register becomes most important. Sir W. Palliser suggests another standard of comparison of pressures —namely, the permanent enlargement of the bore of the gun—which he considers applicable to cases of very great strains. To this is to be objected that there is no standard of this kind established at present; moreover, that such a method of register depends much on the material employed, and is open to the greatest objection when different materials are used. For example, supposing we find a large permanent expansion registered in Sir W. Palliser's gun with coiled iron linings, the advocates of such guns may argue from it that the pressure was enormous, and the gun to be accordingly praised; opponents, on the other hand, may urge that it showed the material yielded, and was therefore bad, rather than that the pressure was great. I am not now speaking of other proofs that may exist of the high pressure, but of the value of the systematic measurement of permanent expansions for this purpose, which I think, under present conditions, open to grave question. To come briefly, however, to what might be looked for in these trials, we have a gun that has already suffered the most severe usage subjected to what any candid person must admit are very exceptionally severe tests. We have the means of forming an idea of the amount of strain due to the powder pressure, if fired under ordinary conditions, if we ascertain what pressures are obtained in the Royal Arsenal from the service 7-in. gun with the same powder. We have no means of directly ascertaining the pressure actually developed, which may be exceptional, the front charge being fired under the impact of the hinder projectile, and, whether by flash or blow, under abnormal conditions. It may be questioned, however, whether the pressure-gauge at Woolwich in the base of the front shot told us very much more than we may safely assume to be the case. We have Sir W. Palliser's system of measuring the bore in various places, which, if not comparable with any known standard, at all events has a special value of its own in telling the exact place where the maximum pressure was exerted. This I hope will be made clear by Fig. 1, which shows the gun in section, double loaded with the maximum weights of charges and shot, as laid down for round No. 5. Underneath this will be seen five spaces running parallel to the bore, like five narrowed longitudinal sections of the bore, with the lengths measured from the muzzle in feet and inches, and the positions of projectiles and charges marked for the five rounds. The diameters of the bore in the various places where it was measured at the conclusion of each round will be found entered on the space so numbered; that is to say, between the upper parallel lines marked "No. 1 round" are entered the measurements of the bore after the first round. The object of this is to enable us to see at once where the enlargement took place, and how far the gun permanently expanded opposite each cartridge or each projectile.

Round 1.—The gun was loaded as laid down in the programme, first with a charge of 13 lbs. 12 ozs., then with an 88-lb. cast-iron shot

with Woolwich gas-check, but without studs, in order to enable it to go home past the termination of the rifling. Over these was rammed home a charge of 10 lbs. 10 ozs., and a 75-lb. cast-iron shot with gas-check and studs. No very marked result was produced on firing. The gun ran up its rails fairly, and the bore was measured as registered in parallel space marked No. 1 round in Fig. 1.

Round 2.—The gun was loaded in succession with 16 lbs. of powder, a 100-lb. cast-iron shot, without studs but with a gas-check, 11 lbs. of powder, and an 85-lb. shot, with studs and gas-check, and fired. The measurements taken afterwards are registered in the space marked for No. 2 round.

Round 3.—The gun was loaded successively with 18 lbs. of powder, 100-lb. shot, 12 lbs. of powder, and an 85-lb. shot, and fired. For this, and with successive rounds, all shot had gas-checks and studs. The recoil was now very violent. A larger number of bore measurements were taken, as shown in the space between parallel lines, "No. 3 round," Fig. 1.

Round 4.—The gun was loaded with 20 lbs. of powder, a 100-lb. shot, 13 lbs. of powder, and an 85-lb. shot, and fired, the expansion being registered in the space between parallel lines marked "No. 4." (Fig. 1).

Round 5.—The piece was loaded with 22 lbs. of powder, a 100-lb. shot, 14 lbs. of powder, and an 85-lb. shot, and fired. The splinter-proof roof fell in over and round the gun, which did not appear outwardly to be injured, but it was impossible to obtain exact results for a considerable time. These results, however, which are not shown on the cuts herewith, were very similar to those obtained in the previous rounds.

There can be no question that the gun stood admirably. I believe that permission was given by the War Office to fire the service 7-in. gun with 30 lbs. of pebble powder and a 160-lb. shot. In actual amount the fourth round consisted of 33 lbs. of powder and 185 lbs. of shot, but the great strain is of course due to the distribution of the charges and shot.

As concerns the local action of the pressures on the bore, taking the registered expansions as far as we have them, we may observe a little inaccuracy in measurement, but this must inevitably occur. For example, the bore at 7 ft. depth increases up to an extent of ·008 in. at the third round, and drops again at the fourth. The bore cannot be measured in precisely the same spot each time, and expansion need not be perfectly concentric and symmetrical. It will be seen that the measures consistently show a maximum permanent expansion opposite the front portion of the front cartridge.

It may require explanation how it is possible for this gun to have stood the tests imposed on it at all. First, then, it must be remembered that coil tubes entered into a cast-iron gun by the muzzle must, of necessity, be as thick, and therefore as strong, at the muzzle end as at the breech end of the bore. Such tubes being strong enough for the work falling on them at the breech, must have a great margin

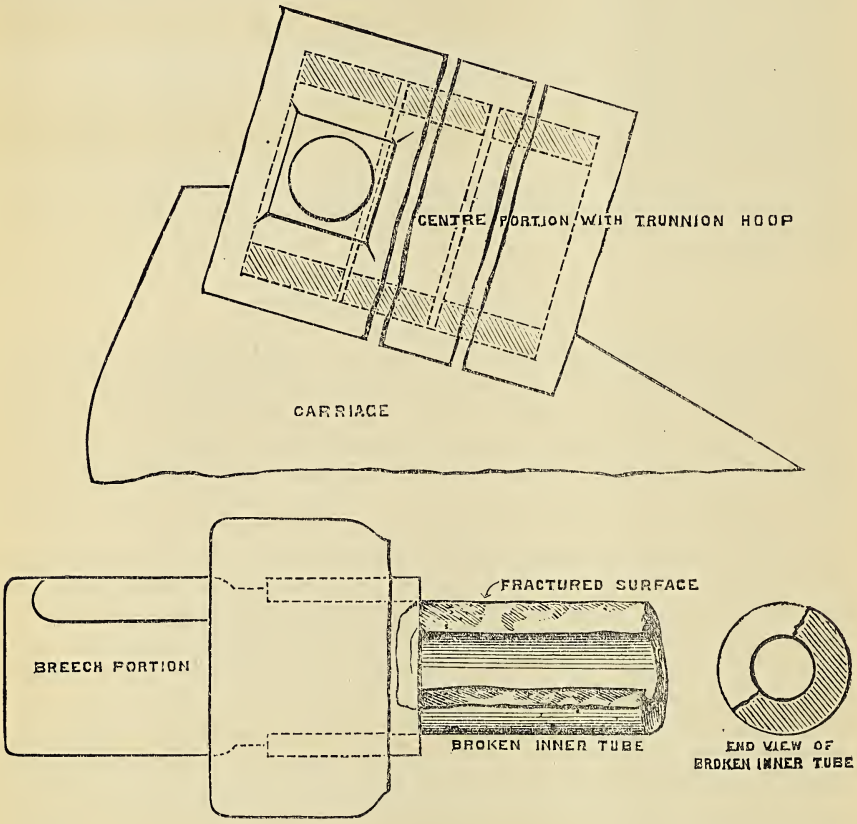
of strength forward—in fact, would be as well able to stand a charge fired half-way up as at the bottom of the bore. They could hardly be better made for this express experiment. If the 7-in. Woolwich gun is allowed to bear on service 30 lbs. of pebble powder and a 160-lb. shot, the mere weight of powder and metal employed, even in the fifth round—namely, 36 lbs. of powder and 185 lbs. of shot—doubtless might be well borne. There remains still the violent and sudden action due to the position of the front charge between the two shot. This action I have said in the case of the 38-ton gun was apparently so violent as not to resemble the normal explosion of powder. This strain Sir W. Palliser's gun, being a converted and old weapon, has borne wonderfully well, and deserves very high praise for it. The coils have been abundantly proved to be admirable. The question may perhaps be raised whether our present large cheap coils would stand as well. As the experiment stands, Sir W. Palliser has made out a good case for coiled inner tubes of iron; but it must not be forgotten that the analogy between large and small guns is comparatively remote, and that both the projectiles used on this occasion were solid.

4. The Krupp Gun Accident.

The annexed illustrations are copies of rough sketches taken by Herr Krupp's engineer, sent to examine the remaining portions of the 9-in. gun of 14 tons which recently burst on board the German training ship "Renown"—a vessel originally purchased from the English Government. The gun in question was manufactured in 1868, and has been in use since 1870. It had received severe usage, and showed deep erosion or guttering about the position where it eventually yielded. One shell which burst in its bore had produced some injury, and it had been remarked upon as a gun which ought not to be fired again. Messrs. Krupp suggest that the probable cause of explosion was as follows:—It was loaded with a chilled projectile with a lead coat. Such projectiles are specially liable to have cracks developed in the chilled metal in the process of re-heating to take the lead coat. This projectile probably became ruptured in firing, and wedged in the portion in front of the trunnions. Hence the gun yielded, the front portion of the barrel being carried away with the projectile, the breech end blown to the rear, and the central portion with trunnion ring left on the carriage with the tubes in the opened condition shown by the dotted lines, which indicate the effect of a great longitudinal strain. It is to be observed that the gun only parted into these large fragments, the men who were killed and wounded being injured by *the gas,* not by actual impact of pieces of metal.

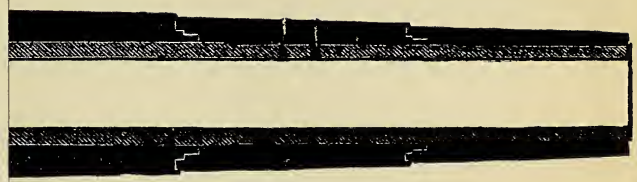
If the gun bursts in a dangerous way and kills the men round it, it is a matter of comparatively small importance whether death is caused by gas or fragments of metal. The burst is to be admired from one point of view, inasmuch as the gun has certainly been subjected to a very great strain, and has yielded simultaneously in various ways—laterally,

as shown by the tearing open of the inner tube; and longitudinally, the breech portion going to the rear, the muzzle overboard, and the trunnion hoop and centre portion opening apparently at every joint. Perfection from one point of view would be for a gun to be so constructed as to have every part proportioned to the strain falling on it, so that it has no weak places, and if overstrained yields by shivering into dust. In England it has been thought preferable to have such lines of least resistance that the gun opens and yields without dangerous results.



5. The Armstrong 100-ton Gun Accident.

The facts of the bursting of the 100-ton gun, as far as they have reached us, are as follows:—The gun, which has already fired many rounds—thirteen and twenty-five have both been said to be the number—and which was undergoing trial in its turret on board the "Duilio," has burst in such a way as to break the steel inner tube and cause the gun to come asunder behind the trunnions, which, with the



E $\frac{1}{4}$ INCH = 1 FOOT

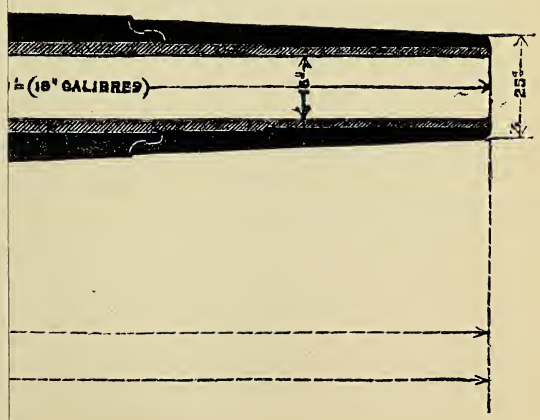


Fig. 1.

THE ARMSTRONG 100-TON GUN.

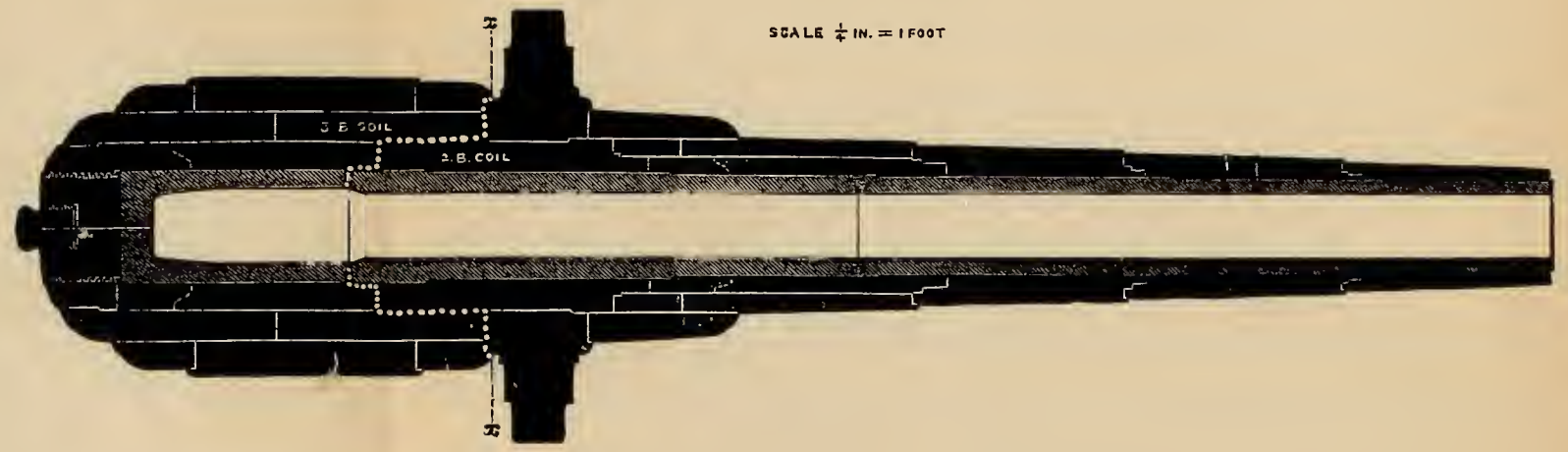
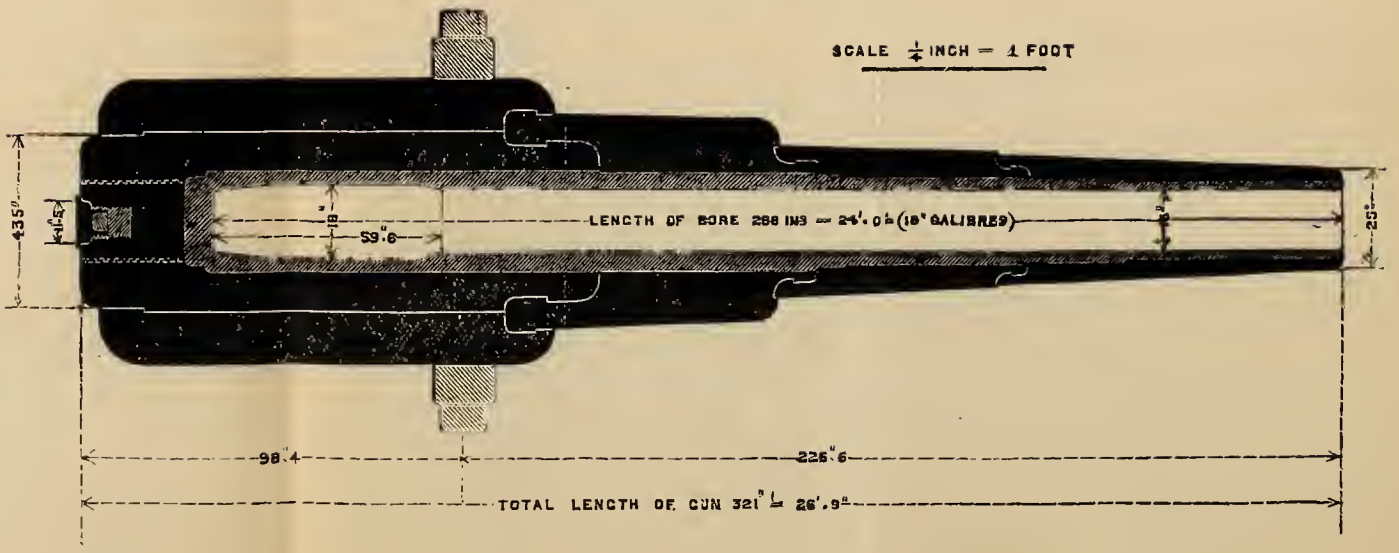


Fig. 2.

THE WOOLWICH 80-TON GUN.



fore part of the gun, remained on the carriage; the breech portion going back against the interior of the turret with sufficient violence to indent the inner steel skin and force the backing against the outside armour-plates—which are 22 ins. thick—so as to open two of them, to a certain extent, "like a pair of folding doors." The wrought-iron coils built on round the inner tube are said not to be injured themselves, but drawn asunder, causing a sufficient escape of gas to burn, knock down, and hurt nine men who were inside the turret. Two only are reported seriously injured, being severely burned; these two having stood close beside the gun, opposite the place where it opened. We are informed that the breech of the gun rebounded from the turret and came back in contact with the muzzle portion still remaining on the carriage. The gun had been loaded by hand with the following ammunition:—A battering charge of 551 lbs. of Fossano progressive powder, and a 2000-lb. projectile. The steel tube is said to have yielded just at or near the base of the truncated cone leading from the enlarged chamber into the bore.

This, I think, sums up substantially what we are told of the facts of the case. Supposing these to be correct, what is to be gathered from them? The following characteristic features should be noticed:—(1) The gun yielded in the longitudinal direction; (2) the steel tube only is broken; (3) the amount of injury done by the gas is very small indeed in proportion to the magnitude of the charge.

I need scarcely remind you that on firing, the work done on the gun in the backward direction is equal to that effected on the projectile moving forward, and that the recoil of the gun is checked through the medium of the carriage, which is held to the gun by the trunnions. Consequently when the gas, acting against the bottom of the bore, is driving back the breech, while the trunnions are being held by the carriage, a longitudinal strain is brought on to the gun between the breech and trunnions, in proportion, on the one hand, to the force of the charge, and on the other to the inertia of the front portion, and the carriage, and the quantity of friction or hydraulic pressure that is brought to bear upon them, in this instance, I believe, through the trunnions, in order to check recoil. This strain must always exist. What is there to resist it? In Fig. 1 is shown a section of the gun in question, which is, I believe, correct. In looking at this section, it will be seen that the longitudinal strength of the gun against extension depends almost entirely on the inner steel tube. The outer coils are short, and are not hooked on to one another so as to assist in holding the gun together longitudinally. Consequently, if the inner tube yielded, it is easy to understand how the gun might be pulled asunder. We are told that the steel tube parted at the base of the conical portion connecting the powder-chamber and bore. If this occurred, the gun might come asunder at the line marked *x* without experiencing much resistance beyond "the friction due to the biting of the front portion of the 3 *B* coil" on the hinder part of "2 *C* coil." The process of yielding would be gradual, depending on the excess of velocity of the breech portion over the more slowly recoiling front portion and carriage. No considerable escape of gas would take place until the front edge of

the "3 *B* coil" cleared the rear edge of the "2 *C* coil." I cannot exactly say where the shot would be when this occurred, but it needs but little calculation to arrive at it. The breech portion and the shot would move through distances proportionate to their weights in this time, the front portion of the gun and carriage would recoil, impeded by inertia and mechanical resistance—hydraulic and frictional—and the breech would doubtless hold on to it, and experience considerable resistance in separating from it. Now, it appears impossible that the *B* and *C* coils could clear each other till after the projectile had left the muzzle of the gun; consequently, the escape of gas must be comparatively very small.

It may be seen that the whole of this accords with what is reported; that is to say, if the steel tube yielded, we might expect the gun to come asunder in the longitudinal direction, to do so gradually, and with but little injury to the exterior coils, and with little escape of gas. While the line I have supposed the gun to yield at, and part of the above explanation, may be only matters of probability, I am informed for certain that the gun has only been fractured in the steel tube, and has gone in the general manner I indicate, and I am only stating what I believe to be the judgment of those best qualified to give an opinion on the matter, in speaking of the accident as I do, as in no way arguing the probability of one of a more dangerous character. It is serious enough, and alarming enough, for a monstrous gun to come asunder in any way. At all events, it is to be said that it has done so in as little dangerous a manner as could well be imagined.

Major Morgan, R.A., once advocated making a gun that was intended to behave every time it was fired very much as this gun has done—that is to say, he made the breech portion separate from the rest, only adding to it a piston, which entered the bore and fitted tight in it by means of a gas-check. This breech portion he intended to recoil, opening the breech some little time after the shot had cleared the muzzle. He considered his system suited to *very heavy ordnance.* With the exception, then, of his tightly-closing arrangement acting before the piston cleared the bottom of the bore, this 100-ton gun has probably in a rough way brought his idea into practice more nearly than many ever expected to see it. If Major Morgan is equal to the occasion, may we not expect him to write from Malta, pointing out that the 100-ton gun was a magnificent weapon, but it had the fault of being a muzzle-loader? Now, however, that it has yielded longitudinally, and without serious injury to turret or men, it has transformed itself not only into a breech-loader, but into a very advanced type of breech-loader, and one which requires absolutely no longitudinal strength.

We must not, however, make light of this matter—which is serious enough. There can be no question that, whether dangerous or not in its results, the gun failed in a way that was never contemplated. Supposing the above explanation right, to what cause is the fault to be attributed? Is it due (1) to some abnormal strain that the gun was never designed to meet; (2) to anything inherent in the wrought-iron built-up system of construction; (3) to some defect in the application of the system to this particular gun; (4) to bad material?

The chamber is reported to be extended as if by an extraordinary pressure. This it is difficult to account for, except on the hypothesis that the character of the powder or the conditions under which it was fired were altogether different from what was intended. If so, it is absolutely necessary to trace the cause, and guard against it for the future. The second question is best answered by comparing this gun with others made on the same system. That which most naturally occurs to me is the 80-ton gun, whose section is given in Fig. 2. This gun is built upon designs made in the Royal Gun Factories, and in some respects it differs from guns designed at Elswick. I instance it, however, because, though constructed on the Fraser coil system, it is at all events a gun founded on the original Armstrong system of coiled wrought-iron over a steel tube, though I should expect a great difference in strength longitudinally on the system of Mr. Fraser. My object is particularly to speak of the guns which chiefly concern this country, and in which confidence may be shaken by the recent accident.

On referring to this figure, it will be seen that the trunnions are incorporated in one piece with a large *C* coil, which extends to the breech of the gun, hooking firmly over the coiled breech-piece. The manner in which this is effected is by forming the trunnions on a hoop encircling the gun of a form shown in the dotted line in Fig. 2, which is placed in position on the portions of the *C* coil, before and behind it, previous to their union, and the three are all firmly welded into one. Supposing, however, for the sake of argument, that the joint below the trunnion ring were imperfect, the pieces butt against the "1 *B* coil" in front, which is hooked on the coiled breech-piece. In short, the entire mass formed by the *C* coil, having the trunnion hoops incorporated in it, the coiled breech-piece, and the "1 *B* coil," is so thoroughly united that it is almost inconceivable that it could be separated longitudinally. The 38-ton gun and others closely resemble this piece. Consequently, we may say boldly that the accident which happened at Spezia is not one to which our English built-up guns are generally liable. Nay more, I think it will be found, on examining other systems, that if there is a gun which is secure against such a contingency, that gun is our Woolwich 80-ton gun, and those which resemble it. Anyone who examines the section above will, I think, set his mind at rest on that score. Next, is there a defect in the construction of this particular gun? If I am correct in my premises, it appears unjust to condemn the gun on this head. I believe that there exists abundant strength in the steel tube, and the resistance supplied by the shrinking on of the coils, to meet probably thrice the strain to which the gun was subjected, if all was right. Nevertheless, speaking as those who are wise after the event, and taught by it that all may not be right, it is impossible not to conclude that a slight modification might be made which would enable the gun to remain intact in defiance of any failure of the steel inner tube. But if we are all wise after the event, it is due to General Younghusband and the Gun Factories to point out the admirable provision made from the first in this way in the 80-ton gun. I do not say that sufficient provision is not to be found in Elswick guns, but not to the same extent.

As to the steel tube, no doubt interests are involved in it which make it wrong to speak certainly of its quality before we hear more. Should the steel tube turn out to be unsound, then unquestionably there is cause for blaming the material of the gun. Of this, of course, we cannot judge at present.

Supposing that there is no fault to be discovered in the steel, can we see how any extraordinary strain could fall on the gun? Air spacing would produce a great *diminution* of pressure. It was not double-loaded, and could not well jam, as it has no studs, and I do not know that it has paper wads. A possible cause lies nearer at hand, though until comparatively recently wholly unsuspected.

The charge consists of 551 lbs. of *Fossano progressive powder*, and there is *no central tube up the cartridge*, and *the gun has an axial vent*. Now, I have received two letters from Sir W. Armstrong, in one of which he tells me that in a recent Elswick experiment, by firing an untubed cartridge by an axial vent, the pressure was increased from 18 to over 50 tons.

NEWCASTLE-ON-TYNE,
11th March, 1880.

MY DEAR SIR,

We have little information about the failure of the 100-ton gun beyond what has appeared in print. The gun was abundantly strong at the point of fracture to resist any *legitimate* pressure, and I have little doubt that the cartridge and mode of lighting by a rear vent are in fault. In some recent experiments of our own we had the pressure exalted from about 18 to over 50 tons per square inch, by igniting at a rear vent an *untubed* cartridge, such as the Italians have been using. The extra pressure is all wave action, and chiefly takes effect longitudinally, thereby tending to tear the gun asunder. A small variation in the quality of the powder, or a slight admixture of pulverised or broken lumps, seems sufficient to set up a localised ignition which throws the whole mass into violent oscillation.

The proper management of the huge charges now used, so as to obtain invariable exemption from this dangerous action, is, in my opinion, the chief unsolved problem in regard to monster artillery.

Yours very truly,

W. G. ARMSTRONG.

P.S.—It occurs to me to mention that within the last few days an 8-in. M.L. gun of ours was fired at Shoebury with charges of 105 lbs. pebble powder, which gave 18 tons pressure in the bore. By way of experiment, cartridges containing a proportion of R.L.G. powder were tried, and it was found that with only 5 lbs. of this smaller powder, mixed with 100 lbs. of pebble, the pressure on the crusher gauges rose to 30 tons, the velocity of the projectile remaining almost the same; so that the extra 12 tons was all wave action. This was with a top vent, and the difference would have been far greater with an axial vent.

NEWCASTLE-ON-TYNE,
16th March, 1880.

MY DEAR SIR,

It is always risky to pronounce judgment on a subject while it is under investigation. An Italian Commission of highly competent persons, who have all the facts before them and have the gun to refer to, are now prosecuting an enquiry

into the cause of the accident, and until their decision be known it is obviously premature to express any opinion. It is certain that rapid local ignition and want of facile diffusion of flame is extremely apt in large and dense charges to give rise to oscillations productive of extraordinary intensifications of pressure, and it is also certain that the calculated strength of the 100-ton gun at the point of fracture is far in excess of what a normal pressure would demand; but you had better hear what the Italian Commission makes out before committing yourself to further criticism.

Noble is not here at present, and therefore I cannot consult him, but will do so on his return.

The quality of the powder for heavy guns, as well as the mode of igniting it, becomes more and more critical as we advance in dimensions, and there is great want of adequate experience on the subject. Nothing, in fact, wants investigation so much as this powder question, and until we arrive at more definite conclusions we cannot hope to be altogether free from accident. My own leaning is in favour of prismatic powder, which affords the advantage of tubular flame space, and occupying little room, thereby allowing the flame to pass freely both through it and round it; but for very big guns I think the prisms should be larger, so as to reduce the aggregate surface to be ignited and lessen the primary production of gas.

Yours truly,

W. G. ARMSTRONG.

Capt. Orde Browne.

This Shoeburyness experiment is known to Gen. Younghusband and other officers present. Therefore we have, apart from Sir William's statement, reason to contemplate the possibility of violent wave action, at all events, if even a small part of the charge were broken up.

Let me remind you, however, that not only is the charge devoid of a central tube, but it consists of progressive powder. The last time I had the honor of addressing you, I spoke of this powder as very excellent for an *individual* result, but surely peculiarly liable to variation —consisting of a mixture of slow-burning and quick-burning powder, so arranged that the slow-burning should be consumed first; but suppose the grains to be at all broken, or even imperfectly formed, the quick-burning powder might be exposed to ignition before the proper time, and then a great effect might be caused.

At Spezia, in the trials in 1876–7, in the early 100-ton gun trials, 275 lbs. of W.A. P^2 powder gave 1542·8 ft. velocity, with a pressure of 21·4 tons. In 1879, in the enlarged gun, 551 lbs. of F. powder gave 1671·6 ft. velocity, with a pressure of 20·38 tons.

This was an excellent result; but suppose the F. powder to have its condition modified sufficiently to bring it to the condition of W.A. P^2 powder, the result produced would be simply that the charge would be doubled.

If, then, we consider the recent effect of axial vent with no ignition tube, altered grain of powder, and the complex character of the F. powder, there is abundant cause for producing an abnormal strain.

Now, we ought to consider the position of a private firm, manu-

facturing guns for others—not like our Government, having only to suit their own requirements, but possibly those of others whose sanguine temperament might make them not care for the extra expense due to superfluous strength. Further, if we consider that the application of the F. powder was the act of the Italian Government, and if we remember the difficulty in tracing home the blame to the only ingredient that was not *English*, we shall desire to show sufficient fair play to Sir W. Armstrong to wait for further information before we condemn his gun—a gun which, remember, was a design passing in a single stride from 38 tons to 100, and which, manufactured in 1875, still remains in 1880 the most powerful gun in the world.

Note.—The conclusions of the Italian Commission on the bursting of the 100-ton gun may be briefly summed up as follows:—Supposing the gun to be made as specified, it is sufficiently strong longitudinally to resist about three times the strain that should fall on it from a battering charge exploding in an ordinary way. Its longitudinal strength is, in fact, greater than its strength in a tangential direction in the proportion of 5 to 4, and is about equal proportionally to that of other guns made on the same system, as well as all their other service guns, and there is no evidence of bad material in the investigations made by the Commission up to the present time. Consequently, the gun being more than sufficiently strong to resist the normal pressure of explosion of a battering charge, the Commission are driven to the conclusion that the charge was fired in such a way as to give rise to an abnormal pressure in the gun, arising, it is suggested, from irregular ignition, such as may occur in firing an untubed charge of great magnitude with an axial vent. The Commission recommend the further investigation of this subject, on which they observe Captain Noble's experiments furnish the only data hitherto obtained. In the meantime they suggest a reduction of the present battering charge from 551 lbs. to 507 lbs., which is to be made up in a cartridge with a tube, to ensure the regular ignition of the powder. They hint *in no way at any alteration in the construction of future guns.* The Commission appear to have gone carefully into the matter, and to give good ground for their conclusions. I cannot think, myself, that their view as to the future is sound. To say that the strain thrown on the gun was of a new and abnormal kind, and that previous experience called for no greater provision of strength than was made in the gun, is one thing; to say that no change is to be made in future guns is another thing altogether. Surely if we learn that a peculiar class of strain may fall on a gun longitudinally we ought to provide for it, and not content ourselves with saying that such a strain is abnormal and ought not to occur, and that we do all that we ought in providing a gun as strong longitudinally as tangentially. If the gun bursts, there is little satisfaction in proving that it behaved unfairly to us in doing so. If a liability to a special strain longitudinally exists, we ought to provide for it, and it can easily be done.

APPENDIX B

OF

PROPOSED LIMBER SYSTEM FOR FIELD ARTILLERY.

BY

MAJOR W. B. E. ELLIS, R.A.

TRANSPORT AND SUPPLY OF LIGHT ARTILLERY AMMUNITION.

Perhaps there is no subject more important than the constant and ready supply and facile transport of ammunition in the field. Without offering any opinion one way or the other on the present or wagon system, it may not be too much to say that there have been occasions when difficulties of ground have been met with on active service which have been surmounted only by the timely aid given to the artillery by men of other arms (generally infantry); and that the wagon body has been found to be the most awkward part (as it is indeed the weightiest) of the equipment. The gun and carriage of the 9-pr. are more manageable over rugged country than the wagon body. Should it then be found possible so to modify the present material that nothing shall be lost in efficiency, while greater handiness is obtained, and light artillery could get along without ever, or very rarely, being forced to call for extraneous assistance, would there not be an advantage gained? Time is a very cogent factor in field operations, and minutes, nay, even seconds, may tell very much in particular cases; and though the present ammunition wagon has been pulled through many a fearful place by sheer force, much delay has been caused by that operation.

Taking the 9-pr. equipment as it stands, 2 small boxes, each containing 6 shells and 6 cartridges, can be placed and secured on the platform board of a limber, immediately in front of the limber boxes, without in the least interfering with the conveyance of all the stores, &c., at present carried. This would bring up the number of rounds on each limber from 36 to 48, or a gain of 12 rounds per gun in action. The limber boxes can be shifted a little back, so as to prevent any increase of weight on the shaft horse. Picket posts can be conveniently stowed under the platform boards of limbers. The extra weight for a gun-team to pull would be almost nominal, or little more than 1 cwt., while the possession of 12 more rounds with every piece in position might be of supreme importance in an action.

In order to carry a spare wheel and a pair of spare shafts with every division of a battery, one of the service limbers of each division can be fitted with a moveable frame and platform at the rear of the axletree,

so arranged as to convey a spare wheel behind the limber (about 6 ins. clear of its wheels), while a pair of spare shafts may ride under the same carriage, with their smallest ends meeting (and neatly housed) under the near shaft. The whole of the stores, &c., now carried on 2 wagon bodies can be packed on or under this spare wheel limber, which would also have its 48 rounds complete, and convey the blankets, kits, &c., of 6 gunners. A light box to hold the stores can be adjusted between the limber boxes and the spare wheel. The limber boxes may be shifted a little forward, in order to balance the shafts. This spare wheel limber completely packed will weigh less than half the service wagon in marching order.

On a war footing a wagon has 6 horses as well as its gun. A division of a battery thus takes up 24 draught horses, and carries 148 rounds per gun, including axletree rounds. If to every 2 guns there were 2 modified limbers limbered up, and 2 similar limbers following separately, beside one more limber carrying spare wheel and shafts, and the guns had 6 horses each, while the 3 separate limbers had 4 horses each, there would be 24 horses required in all, and a total of 124 rounds per gun would be carried. Reserve ammunition columns are indispensable adjuncts of a field force, and every wagon of this reserve with 6 horses would convey 108 more rounds per gun. A reserve limber, with 48 rounds, could travel well with a pair of horses, as it will not be required to move so rapidly as limbers close up with the battery. Two wagons in reserve would give 216 more rounds per gun, or a total of 364 rounds for each gun on the wagon system. Five limbers, with 48 rounds each, would convey 240 rounds per gun, and would require but 10 horses to the 12 necessary for 2 wagons. There would result a clear economy of 2 horses and 1 driver for every gun on a war footing turned out on the modified limber plan, and completed to the extent of 364 rounds per gun. By a careful comparison it will be found that the wagon system equipped with the above amount of ammunition would have a proportion per gun of wheels and shafts as follows: namely, 4 pairs of shafts and 3 spare shafts, and 16 wheels and 1 spare wheel. A modified limber system would have $7\frac{1}{2}$ pairs of shafts and 3 spare shafts, and 17 wheels and $1\frac{1}{2}$ spare wheels, per gun. With the wagon system there would be 4 carriages travelling per gun as against $7\frac{1}{2}$ separate carriages with a modified limber plan; but yet the difference in the length of column would be very small, and would be chiefly due to the greater accumulation of loss of distance with the larger number of vehicles; but would not this be more than compensated by the greatly increased mobility of each component part of the column of ammunition? It would not be difficult to keep the drag for each horse of a reserve limber down to 8 cwt., and every animal would be in draught to the fullest advantage close to its load.

In peace establishments in England we have only one ammunition wagon to 2 guns, and the wagon has only 4 horses. This gives a proportion of 8 horses per gun with 94 rounds; 12 wheels would be in use with 1 spare wheel carried, and 3 pairs of shafts in use with 1 spare shaft carried. If 1 spare wheel limber were allotted in peace to every 2 guns instead of a wagon, it could be drawn by 2 horses. There

would then be only 14 horses, or 7 horses per gun, wanted, and a total of 76 rounds only carried for each gun—a matter of little moment on a peace footing ; there would be 10 wheels only in use and 1 spare wheel carried, also 3 pairs of shafts in use and 2 spare shafts carried.

It is clear that a saving of one horse per gun could be thus made on a peace establishment. The total weight of the equipment on the modified limber plan, as compared with the wagon system carrying an equal amount of ammunition, would be very considerably in favour of the limber system.

The cost of conversion would be comparatively small, and would only consist in the addition and fitting of the small extra boxes and wheel limber frames. This would be a final cost also, whereas the saving in the purchase and keep of horseflesh is continuous, and would soon show a large credit to the side of the limber system.

May it not, then, be claimed for the proposed modification that it would very materially lighten the artillery equipment generally, and also very much facilitate the transport and supply of ammunition in the field, without having so many eggs in one basket, as is the case with the present wagon system; and that a positive increase of efficiency might be obtained, combined with a decrease of expenditure ?

The whole of the present wagon equipment could be utilised until worn out by being made use of in the second reserve ammunition train, so that there need be no waste of material owing to the proposed modifications.

FIELD RANGE-FINDING.

BY

LIEUT. E. G. EDWARDS, R.A.

Few practical artillerymen will deny that the important question of field range-finding is still on a very unsatisfactory footing, though numerous committees and individuals have tried their hands at its solution.

The subject seems to require consideration under two heads:—

1st. The conditions to be kept in view in the selection of a system of range-finding with regard to the nature of the apparatus, and the powers of the men who are to use it.

2nd. The system of teaching, and the objects to be aimed at in teaching, the practical use of the same, so as to ensure efficiency. Also the organisation necessary to attain the same end.

The Committee on Range-finders was appointed for the elucidation of the former, and the Okehampton experiments in 1875 drew forth some remarks on the latter in the official report of the Committee.

On the recommendation of the Range-finding Committee, two systems of field range-finding have been adopted into the service, neither of which is satisfactory; and though the suggestions of the Okehampton Committee with regard to necessary modifications of battery establishments by an increase of men and horses have not been carried out, some attempts have been made to supply batteries with range-finders of the approved patterns, and to exercise the men in their use; but hitherto these efforts have only led to a general condemnation of the instruments, and have served to show how necessary it is to have some definite system of instruction, and to make certain modifications in the present battery establishments.

It would appear, then, that we have neither fully recognised the conditions to be fulfilled in the choice of a system, nor adopted proper means for teaching the art of range-finding.

1st. With regard to the selection of the system. A range-finder must be one of two things—either a more or less complicated machine, involving more or less calculation and adjustments, which can only be put into the hands of an expert; or it may be a perfectly simple affair,

involving neither calculation, adjustments, nor ambiguity, which can be worked successfully and understood thoroughly by any intelligent soldier with a few hours instruction. A certain nicety of observation, however, is always required to attain accuracy, unless the bases are inconveniently long.

Both the instruments adopted by the Range-finding Committee belong to the former class (though, perhaps, the best representatives of their class), and to this their failure would seem to be attributable. We must therefore look in the other quarter for success.

All trustworthy systems are based upon triangulation—which means measuring one or more sides and one or more angles of a triangle, and calculating therefrom by some means other sides or angles which cannot be measured; in other words, solving the triangle. These systems only differ from each other in the variation allowed in angles and bases, and in the mode of solving the triangles.

The more variation allowed, the more intricate becomes the machine, and the more calculation of one sort or another is involved; the less variation allowed, the simpler the machine, and the less calculation involved.

There are very few systems—if they can be called systems—which are independent of triangulation. Amongst them may be mentioned the telemeter, depending upon the rate of travelling of sound, and the long-wished-for telescope, which ought to have a different length of focus for each 10 or 50 yds. range, but has not.

To return to practicable systems. The only difference between the two service range-finders—Nolan's and Watkin's—*in principle*, is that in Nolan's the base, and both angles at the base, vary within certain limits; while in Watkin's the base (within certain limits) and one angle at the base vary, the other angle being a right angle and constant. In the former, the base and base angles being measured, the necessary calculation is performed mechanically; while in the latter, the calculation is performed by the same mechanical process by which the variable base angle is measured, the variable main base having been previously measured in a similar manner, by measuring from one end of it the angle subtended by a short constant base of 18 ft. set off at right angles to the other end of the main base.

The angle-finder in the former is on the principle of a theodolite; in the latter on the principle of a sextant.

Innumerable systems have been proposed and experimented upon, from time to time, differing more in mechanism *and name* than in principle; and would-be inventors would do well to consider and lay to heart this fact before rushing into the thorny path of invention, with its costly experiments and inevitable disappointments.

The following is a summary of *nearly* all possible systems of triangulation, in which it is assumed (1) that one of the long sides of the triangle is an unknown quantity and the required range; (2) that it is impossible to measure directly the apex angle of the triangle when the object forms this apex; and (3) that the base and base angles are known, or can be measured.

Under these circumstances—

I. Base and base angles may vary. (This is the surveyor's method, and best for surveyors.)
II. Base and one base angle may vary, the other base angle being constant.
III. Base may be constant, the base angles varying.
IV. Base and one base angle may be constant (generally a right angle), the other base angle varying.
V. Base may be constant, the base angles varying but *equal*.
VI. Base may vary, the base angles being constant.
VII. Base may vary, the base angles constant and *equal*.

The following may be mentioned as examples of these seven classes :—

I. (1) The surveyor's plan—viz., theodolite and chained base; (2) the military surveyor's or reconnoitring plan—viz., pocket sextant or prismatic compass, and base measured by chain or by pacing; (3) Nolan's service range-finder; and (4) Edwards' range-finding plane table.
II. Watkin's field range-finder.
III. (1) Berdan range-finder (German); (2) pocket sextant, in conjunction with 50 or 100 yds. base and tables.
IV. Adie's telemeter, containing its own base 1 yd. long; (2) Captain Poste's micrometer; (3) Edwards' range-finding sextant; (4) pocket sextant, in conjunction with 50 or 100 yds. base, and tables or "scales of tangents" for each minute difference in the variable angle from 85° to 90° or from 80° to 90°.
V. (1) Elliott's micrometer telescope, depending upon a man 6 ft. high or height of a mounted man as base; (2) some of the yard telemeters.
VI. Edwards' (broke down at Aldershot on unfavourable ground, but remarkably rapid and accurate on the flat).
VII. (1) Weldon's; (2) Edwards'.

Space will not admit of describing and considering the merits or demerits of each of the above in detail, but it may be observed that classes I. to V. are intricate systems, classes VI. and VII. are simple. All are practicable under favourable conditions, and all are reliable except the yard telemeters in classes IV. and V.

Angles are principally measured (1) by traversing telescopes (with or without cross-hairs) on tripod stands or other support (like a theodolite); (2) by reflecting mirrors held in the hand (like sextants, optical squares, &c.); (3) by totally reflecting prisms, which with the preceding mirror arrangements are used in conjunction with telescopes or otherwise; (4) by a traversing arm provided with sight-vanes on tripod stand.

Specimens of the above are (1) Nolan's, Berdan; (2) pocket sextant, Watkin's, Weldon's, Edwards' (classes IV., VI., and VII.), some of the yard telemeters, &c.; (3) Weldon's, Aidie's, Edwards' (class VII.); (4) Edwards' (class I.)

Bases are measured (1) by tapes graduated in yards, feet, and inches,

or otherwise; (2) by wires or lines with or without marks every 5 or 10 yds.; (3) indirectly or mechanically, by the use of a short auxiliary base, such as length of gun, height of man, or short tape—which latter may be of a constant length or otherwise; (4) by pacing, but this is not sufficiently accurate for long ranges.

Examples of the foregoing are (1) Nolan's, Edwards' (class VI.); (2) Weldon's, constant base for Edwards' (class IV.) or sextant (classes III. and IV.); (3) Watkin's, Edwards' (classes I. and VII.) When bases are supposed to be known without measurement of any kind, they are generally 1 yd. long, a rigid bar or tube of metal, which if bent becomes unserviceable, or an axle of a carriage (Berdan), or a man in the enemy's ranks exactly 6 ft. high, who ought to stand on a glass stool for accurate observation.

Calculation may be performed (1) mechanically, by a separate instrument; (2) mechanically, by the same process that *angles* are measured; (3), mechanically, by the same process that *bases* are measured; (4) by reference to tables, ready calculated to correspond to each minute in angles or each foot or inch in bases; (5) by plotting the angles and bases to scale, and measuring with a graduated index-arm, or by the intersection of two index-arms.

Examples of the above are (1) Nolan's; (2) Watkin's, Elliott's, Aidie's, Poste's, Edwards' (class IV.); (3) Weldon's, Edwards' (classes VI. and VII.); (4) sextant (classes I., II., and III.); (5) Berdan's, Edwards' (class I.)

Having now a bird's-eye view of existing range-finding systems and apparatus, we may proceed to examine their adaptability to military purposes, as regards (1) angle-finders; (2) measurement of bases; and (3) calculations.

(1) The best and most accurate angle-finder no doubt is a traversing telescope, provided with cross-hairs, of moderate power, but comparatively large field, on a steady stand. Such an instrument will measure an angle to an accuracy of 1 minute. But stands are cumbrous, and must be heavy if used in a strong wind, and if gun is used, range-finding party cannot be sent in advance of battery; also, owing to the size of field, telescopes require vertical and horizontal adjustments, and the angles must be read by verniers. The next best angle-finders are on the principle of a sextant, which do not require stands, and will also read to 1 minute, but require great nicety of observation, unless provided with a telescope which reduces the field. Also there is a certain difficulty when objects are not in the same horizontal plane. The same remarks apply equally to prisms, except that the latter are chiefly used for measuring constant angles. The least accurate angle-finder is the traversing arm with sight-vanes, which will measure to within 5 or 10 minutes, but is handy to use.

It is easy to calculate the effect of an error of one or more minutes on the range from the fact that the length of a circular arc whose radius is unity is ·0002909, or 4 ft. 4 ins. in 5000 yds.

(2) As to measurement of bases, it is exceedingly difficult to measure a long base accurately on broken ground, especially in a high

wind. Long tapes break, and require frequent renovation of graduations and figures, when used on rough ground in wet weather. Lines or wires are better, but are awkward to wind up, and if provided with numerous tallies for graduations become cumbrous and heavy. Constant bases 50 or 100 yds. cannot always be obtained, and even when they can, the view of the object or the other end of the base may be obstructed by buildings, trees, &c., or troops. Instruments containing their own base 1 yd. long or otherwise may become bent. Men 6 ft. high in the enemy's ranks sometimes decline to stand at attention while observations are being made on them. On the whole, perhaps a moderately long base, measured by means of a short auxiliary base, is the best for military purposes.

The effect of a given error in measuring the base increases with the range, unless the base increases in the same proportion as the range. An error of 1 yd. in a base of 100 yds. causes an error of about 20 yds. at 2000 yds. range.

(3) Calculation is of course inadmissible in the field, and the mode of getting over this difficulty has generally been the chief characteristic of different inventors' ideas on range-finding. There are literally hundreds of ways of doing it, none of them possessing any very marked advantage over the other; but all, or nearly all, effect their object. Some are more accurate and admit of closer reading than others; but in this, as in everything else, the simplest plan is the best for military purposes.

The fewer distinct operations in finding a range the better, so we may discard at once separate pieces of apparatus such as Nolan's calculating roller, or books of tables. Pencils are apt to lose their points or get lost themselves on service, so the plotting system may share the same fate (Edwards', class I.)

Micrometer screws and vernier scales are likely to be read hurriedly when bullets are flying about; so practically we are reduced to the method by which the range in yards is read direct from a tape, and it is difficult to see how any other plan can compete with such a simple device.

Briefly, if accuracy is to be attained in measuring the range, we must have accuracy somewhere in the observations and measurements; and it is much better to leave accuracy of adjustment of instruments to the manufacturers, whose business it is, than to do it ourselves. This is accomplished by using an angle-finder fixed at a constant angle. If all necessary calculation can be done for us by actuaries or Babbage's calculating machine, and the results printed in a line, one below the other, on a tape, why not let it be so, instead of injuring our eyes by reading verniers? Here it may be remarked that it would be highly desirable, for more reasons than one, that only one man should be required in finding a range; but as this generally involves some sacrifice of speed, we shall probably have to content ourselves with a system which admits of working by one man alone on an emergency.

In selecting a system of range-finding, all we have to do really is to choose between intricate and simple, and fix our standards of simplicity and accuracy, which latter might be from 1 to 2 per cent. of range. Lastly, if experts—specially selected and carefully trained

officers or N.C. officers—are to handle the instruments, to keep them in repair and adjustment, and are to be told off entirely for range-finding duties, we may and should select from classes I. to V. But if, on the other hand, any soldier is to learn the art, and having learnt it not to forget it; if the instruments are to be subjected to rough and tumble work, carried anyhow and anywhere, and are not to require repairs other than the battery artificers can execute, we have no choice but in classes VI. and VII.; or at any rate we must look in that quarter for ultimate success by encouraging proposals for the solution of the difficulty, and above all by carrying out practical and *bonâ fide* experiments with them under service conditions.

Some definite standard of simplicity of gear, &c., must be fixed upon, and having secured that, take whatever can be got in the way of elasticity, accuracy, and reliability; in fact, carry out the old rule for building a cannon—viz., get a hole the size you want, and put some brass round it.

2nd. Having got an instrument, men must be taught how to use it, and arrangements must be made to provide for its efficiency when entrusted to batteries. This subject may be conveniently considered under separate headings.

(1) The present system, and cause of failure.
(2) The arrangements necessary to ensure success.

(1) The present system consists of pitchforking sets of range-finding apparatus into batteries in which probably there are neither officers nor men who have any knowledge of or taste for the subject, or time to devote to it; leaving them to find out for themselves how to work it or to leave it alone—of which two courses open to them they probably elect the latter.

This leads to the instruments getting out of order from ignorant handling, and to their being ultimately shelved in the battery store as useless encumbrances; as both officers and men already have plenty of work to do which they do understand, without saddling themselves with work which they do not understand, and have no chance of learning to master.

(2) As long as range-finding duties are superadded without any corresponding increment of men and horses, the battery establishments having been already cut down to the lowest possible working limits, without making any allowance for casualties, range-finding is sure to be voted an intolerable nuisance. The first step, therefore, before any progress can be made, should be to increase each battery by one or two men and horses, whose chief duty will be range-finding, though they might be available for other work.

The next point to consider is the machinery for teaching the art of range-finding on a systematic principle; and here we shall probably encounter opposition at the outset. For, in the first place, it consists in the formation of a centre of instruction, on however small a scale; otherwise the requisite uniformity will never be obtained, and each battery commanding officer will have his own ideas on the subject, which he will endeavour to carry out, whatever they may be.

The School of Range-finding should be organised on the same principle as the School of Army Signalling already in existence, and might be either for artillery alone or for the army.

The first and most vital point to be considered is the locality, which leads us at once to condemn such places as Woolwich or Shoeburyness, and to recognise the incomparable superiority of such a place as Aldershot, where there is a great extent and infinite variety of ground, all War Department property, presenting nearly every difficulty which would occur on service, and every salient feature of which has its own name and is marked on the map; besides which the constant field-days afford the best opportunities for sending out the instructors in attendance on batteries to note the positions they take up and the objects they fire at for subsequent practice with the range-finders.

The preliminaries to the establishment of the school would therefore be as follows.

The staff of instruction, consisting of an officer instructor and two N.C.O. assistant instructors, having been selected, should be sent to Aldershot at the commencement of a drill season. They should attend R.H.A. and field batteries on all field days. They should be provided with a 6-in. map, on which they should note every position the batteries take up, also the points upon which they receive orders to fire. If these points are troops, the nearest stationary object should be noted and marked on the map, also any difficulties, such as proximity of other troops, &c. The ranges should be measured rapidly at the same time, and the results compared with the map; and next day the same ranges should be measured, both deliberately and against time by the staff, no matter what the weather may be. After a month's practice, a dozen or twenty officers and N.C. officers or men may be selected from different batteries and sent to the school for a month's instruction in range-finding and the construction and care of instruments, and should be exercised only over the ground occupied by the batteries and in all weathers.

In this manner the tendency to select only easy ground, objects, and weather would be overcome, and greater confidence in the instruments would be the result. Otherwise the instructor inevitably selects for himself a few elevated plateaux, whence a number of church spires or factory chimneys are visible, of which he and his pupils find the range *ad infinitum* (on fine days).

Practice is required in finding the ranges of ill-defined objects such as troops, lines of entrenchments, woods, tops of hills, points in roads, rivers, or ravines, from positions presenting difficulties of ground and obstacles such as intervening buildings, trees, hillocks, ditches, &c., not only between the ends of the base but also between the ends of the base and the object. Such practice will gradually bridge over difficulties which at first appear insurmountable.

Of course the present service range-finders would be used at first, but the school once established, more attention would be directed to the subject, and there would be increased facilities for giving new proposals a fair trial; and the conditions to be fulfilled would soon become apparent when systematic attempts were made to instruct officers and men in the use of the instruments under varying conditions of ground, objects, wind, and weather.

RANGE-FINDERS.

BY

LIEUT. E. G. EDWARDS, R.A.

The introduction of the above subject by Major J. B. Richardson in the "Proceedings" of December, 1879, induces me to offer the following description of a system of range-finding somewhat resembling that described by Major Richardson.

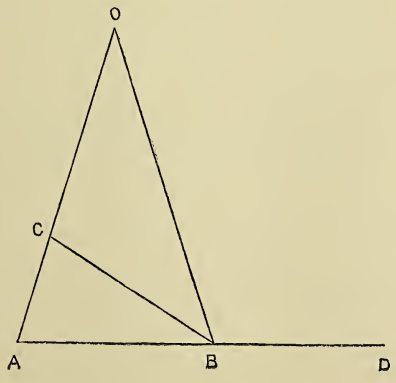
The principle up to a certain point is the same—namely, an isosceles triangle, of which the angles are constant, the object whose range is required being at the apex of the triangle, and two observers at the extremities of the base, which bears a constant proportion to the sides of the triangle, or the range.

So far the two systems are identical, except that in Major Weldon's the constant proportion between range and base is as 20 to 1, while in the other it is as 18·973666 to 1, or roughly 19 to 1.

Major Weldon obtains the range by measuring the base and multiplying by 20. Both of these operations are open to objection, especially the former, if the base is long and the ground broken; while calculation of the simplest kind should be avoided, if possible, in the field.

These difficulties may be overcome by employing a short auxiliary base, bearing the same proportion to the main base that the main base bears to the range.

Fig. 1.



The application of this principle is evident from Fig. 1, in which AC represents the auxiliary base, O the object, AB the main base, and AO or BO the range. The angles OAB, OBA, BCA, and BAC are all equal, therefore the triangles OAB and BCA are similar. Hence the proportion

$$OA : AB :: AB : AC.$$

Therefore $$OA = \frac{AB^2}{AC}. \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

But $$AB = AC \times 18{\cdot}973666. \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Substituting in (1) the value of AB in (2), we obtain

$$OA = \frac{AC^2 \times (18{\cdot}973666)^2}{AC},$$

$$OA = 360AC.$$

In other words, each inch in the auxiliary base AC is equivalent to 360 ins. or 10 yds. in the range OA. For the accurate measurement of AC a short tape is provided, 50 ft. long, or 600 ins., which represents a range of 6000 yds.; and each inch graduation of the tape is figured according to its corresponding range, which dispenses with all calculation. In a high wind a piece of inextensible fishing-line is used to measure AC, and the range is ascertained by winding up lengthways on a stick 25 ins. long, graduated in inches in opposite directions on each side. Thus each complete turn is 500 yds. range, a half-turn 250 yds., and the odd tens are read from the side scales.

Instruments such as Major Richardson describes, though extremely simple, do not measure angles with sufficient accuracy for an artillery range-finder. Telescopic power is almost indispensable, for more reasons than one. In the first place, the object is frequently ill-defined; secondly, it is necessary to guide the eye in the true direction through the duplex mirrors: otherwise there is a considerable variation in the angle reflected, according to the way the instrument is held. With a telescope, however, the eye can only look through the optical axis of the telescope, and if the mirrors are fixed in the proper position with regard to this axis, only one angle can be seen between objects by reflection, and that the true one.

In the system under consideration the constant angle is 88° 29′ 23·657″, or, roughly, 88½°. The natural secant of this angle is 37·947332, which, divided by 2, gives 18·973666, the constant proportion above mentioned. The instrument for reflecting this angle is made in two forms. Either a small square metal box, open in front and on one side, containing a prism fixed in a frame and screwed to the bottom of the box, with a telescope to screw into a circular hole in rear; or a pair of mirrors similar to those of a sextant may take the place of the prism. The telescope is of the Galilean construction, of considerable field and light, but low magnifying power. A complete set of three such instruments will fit into a binocular case, and weighs about 2½ lbs.,

which, with the tape, weighing a few ounces, forms a complete set of apparatus; so there is not much to complain of on the score of portability.

The range-finding party should consist of three men, to attain maximum speed, and the following are the rules for guidance in using the apparatus.

The range-finding party being at *A* ((Fig. 1), and the range of an object *O* required, No. 1 and No. 2 agree upon a prominent part of it, and make a rough guess at the range (an even number of hundreds of yards), and divide by 20, which gives the length of the main base approximately. Supposing the range to be estimated at 2400 yds., then 120 yds. will be about the length of the main base. Both No. 1 and No. 2 now direct their telescopes on the object, and observe what object on the horizon (or otherwise) at *D* is seen by reflection at or near *O*. No. 2 runs out 120 yds. in the direction *AD*, No. 1 watching him, and calling "Right (or left) incline," if he diverges from the line *AD*. On completing 120 yds. No. 2 turns about, and directs his telescope on No. 1, while No. 1, looking at No. 2 through his telescope, moves slightly right or left until he sees the object *O* exactly coinciding with No. 2 by reflection. No. 2 observes whether the reflection of the object *O* falls to the right or the left of No. 1. If to the right, he retires; if to the left, he advances straight towards No. 1. Whenever No. 2 moves, No. 1 maintains the true angle at *A* by moving slightly right or left, which is only necessary when No. 2 does not move perfectly straight. When No. 2 arrives at the point *B*, where the object and No. 1 coincide by reflection (No. 1 being also correctly placed at *A*), both No. 1 and No. 2 stand fast. This is the first part of the process, and is much the same as Major Weldon's. The second operation is to find and measure *AC*, the third proportional to the range *OA* and the main base *AB*. No. 1 makes a half-turn, faces the object *O*, and lines No. 3 on it; No. 3 taking the ring-end of the tape, and No. 1 allowing the tape to run out as far as the graduation marked 2400 (the estimated range), where he holds it. No. 3 stretches the tape taut, and looks at No. 1 through his telescope, moving "in" (towards No. 2) or "out" (from No. 2) as directed by No. 1, who places No. 3 so that when he looks at the centre of No. 3's instrument he sees No. 2 coinciding therewith by reflection. No. 3, looking at the centre of No. 1's instrument, sees the reflection of No. 2 either right or left of it. If left, he retires; if right, he advances. No. 1, who must not move at all, corrects No. 3's position after each movement, by saying "In" or "Out." When No. 3 arrives at *C*, the true position, the distance between the centres of the instruments, *AC*, is measured with the tape, and No. 1 reads the range at once by inspection.

Though lengthy to describe, the whole operation of finding a range only takes 1½ minutes.

It will be observed that No. 3's movements are the converse of those of No. 2. Hence the following general rule:—

When working on the right of a base (whether principal or auxiliary) *retire* if the reflection of the distant object falls to the *right*

of the observer at the left end of the base, and *advance* if the reflection falls to the *left;* when working on the *left* of a base, *retire* if the reflection falls to the *left,* and *advance* if it falls to the *right:* the distant object or apex of the triangle being always considered the front.

When the object is ill-defined, it may be necessary for one man alone to form the triangle *OAB.* In this case No. 1 directs his telescope on the object, and places himself at *A,* so that he sees some well-defined object, *D,* on horizon (or otherwise) coinciding with *O.* He points out the object, *D,* to No. 2, who takes No. 1's place at *A,* while the latter finds *B,* by looking at No. 2 and moving backwards or forwards, being kept in line with *D* by signs from No. 2. No. 3 now assists No. 1 as before.

Other modifications become necessary with reduced numbers, but need not be described here, beyond stating that iron rods with marks or discs on their heads take the place of men. Three such rods should form part of a complete equipment, so that one man can work unassisted.

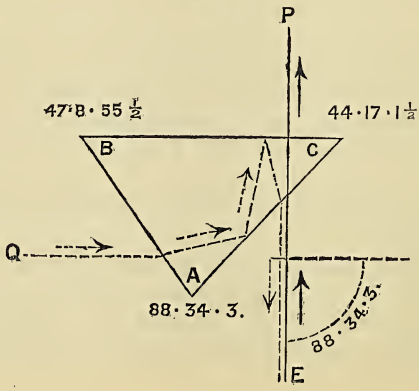
Opinions may differ as to the merits or demerits of a system of range-finding depending upon constant angles and bases, and such systems do undoubtedly break down now and again on unfavourable ground; but many practical artillerymen will consider that the perfect simplicity of such systems more than compensates for the occasional difficulties encountered, which practice will make ever fewer.

Remarks on Major Weldon's Range-finder.

In his description of the prism used to measure the constant angle, Major Richardson observes that the angle of the prism opposite the silvered face is "carefully ground to 88° 34′ 3″;" but we are not told anything about the other two angles of the prism, and the natural inference is that they are equal. It may therefore be worth while to point out that one base angle must be half the apex angle. The three angles will be 88° 34′ 3″, 44° 17′ 1½″, and 47° 8′ 55½″; total 180°.

The action of the prism is shown in annexed figure; the line *EP*

Fig. 2.



representing the line of direct vision, and the dotted lines from *Q* to *E* the course of a reflected ray from the object *Q*, which on arriving at the face *AB* is bent towards a normal at that point through an angle of about $1\frac{1}{2}°$ (this being the "refractive index" for crown glass), and again in the opposite direction on issuing from the face *AC*.

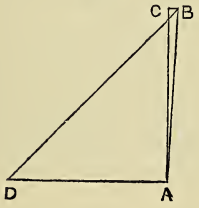
The figure represents the prism in use at the left end of the base; eye at *E*, the other observer at *P*, and the distant object at *Q*. If used at the right end of the base it must be turned upside down.

It is possible to make a prism with equal base angles to do the same work from either end of the base without reversing; but in this case the apex angle must be about $90\frac{1}{2}°$, and each base angle about $44\frac{3}{4}°$. The angles reflected by such a prism, however, vary considerably, according to the way it is held—a defect which renders the instrument worthless for range-finding purposes, unless used in conjunction with a telescope to guide the eye in the true direction through the prism.

Again, in describing the duplex mirror arrangement, Major Richardson observes, "The mirrors are inclined to one another at an angle of 88° 34′ 3″." Such an instrument, if it reflected any angle at all, would reflect an angle of 177° 8′ 6″; but, as a matter of fact, no reflection at all would be seen, because the observer's head would be in the way. The proper arrangement would be to incline the mirrors at an angle of 44° 17′ 1·5″ to each other; as it is a well-known rule, founded on the principle of the sextant, that the angle observed is always double the angle between the faces of the mirrors.

No instrument maker would undertake to grind and finish a prism to an accuracy of 1″ for 30s., though he might offer to do so for £30. It may be worth while to examine into the possibility of such an achievement. Take a prism (Fig. 3) having a side *AB* 1 in. long.

Fig. 3.



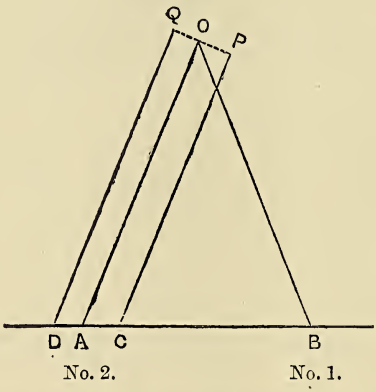
From centre *A*, radius *AB*, describe a short arc *BC*. If the angle *BAC* is 1″, then the length of the circular arc *BC* will be ·0000048 in. In other words, a difference of 1″ in the angle of the prism would represent a difference of $\frac{48}{10000000}$ of an inch at the corners. At least five times this amount is taken off each time the faces are polished, so the difficulty of attaining such accuracy is apparent.

Looking at it from another point of view, the length of a circular arc of 1″ at a range of 5000 yds. is only ·864 ins., or about the thickness of a man's finger, and it would require an uncommonly powerful astronomical telescope to enable an observer to distinguish one side of a man's finger from the other at such a range. Indeed, at

5000 yds. the length of circular arc of 1′ is only 4 ft. 4·362 ins., or the width of two men standing in line, which would look a mere dot, even with good field glasses. It would appear, therefore, that an instrument possessing accuracy within 1′ of true angle would be good enough for practical purposes.

In describing the mode of using the apparatus, the writer first states that "No. 1 goes to the right and finds the angle, No 2 going to the left to find the base." Subsequently he observes, "No. 2 now sees in the angle-glass whether the reflection of the object falls to the right or left of No. 1. If right, No. 2 must retire; if to the left, he must advance, to reduce his distance from No. 1." On reference to Fig. 4

Fig. 4.



it will be seen at once that if No. 2 is at *D* he will see some point *Q* over No. 1, and therefore object *O* will appear a distance equal to *OQ* to the right of No. 1 at *B*. No. 2 must therefore walk in instead of out. Again, if No. 2 is at *C* he will see some point *P* over No. 1, and therefore the object will appear a distance equal to *OP* to the left of No. 1. The proper rule for No. 2 is: when working on the left of a base, retire if the object is to the left and advance if it is to the right; when working from right of base, the reverse.

THE

ATTACK OF ENTRENCHMENTS BY FIELD ARTILLERY.

BY

MAJOR W. KEMMIS, R.A.

(*The R.A. Institution Gold Medal Prize Essay, 1880.*)

"Ex animo operemur et summâ potestate utamur."

In the employment of field artillery the maximum effect may be obtained from the arm, or—due perhaps to clumsy handling or unscientific application—but a fractional part of its power may be utilised. In the latter case it may nevertheless fall out, from some extraneous causes, that the end in view may be obtained; but even so, can we consider the faulty action to be justified? Clearly not, and the probability is that in the improper or imperfect use risk is run, while there is almost certain to be definite loss in *personnel, matériel,* time, or labour, and there most assuredly must be in experience towards training for greater future efficiency.

On every ground, therefore, it is an error, under any circumstances, to make other than the most proper application which the arm, as it exists at the time, admits of.

Taking the field artillery of Great Britain, as it now stands, it will be our endeavour to show how it can best be made use of in the attack of field entrenchments, at the same time making such suggestions for improvement as may occur to us.

In doing this it seems advisable to treat the subject first as a question of gunnery and secondly as a question of tactics—tactics of the unit in the first instance and then of the mass.

I.—The Attack of Field Entrenchments as a Question of Gunnery.

The main object of the universal use of entrenchments on the field of battle is to obtain cover from the enemy's fire; the latter, under modern conditions, being so effective and therefore so deciding in the fight. To nullify this object is, and ever must be, the province of artillery.

The arm may carry out this its *rôle* by one of three methods—namely, by destroying the shelter, by searching out effectually the cover afforded, or partly by destroying and partly by searching out.

We have, then, to determine which plan it is best to pursue; and, in

following it, which is the proper shell*—common or shrapnel—to use, as well as the most suitable trajectory and point of burst of that projectile.

Field entrenchments vary much in character and detail, according to their end and the time and means available for their construction. They are usually classed as, (1) hasty entrenchments for artillery, (2) hasty entrenchments for infantry, (3) field works.

It will be necessary for our purpose to take in each class what may be regarded as a typical form and examine the effect of the projectiles fired against it.

For covering guns the entrenchments made use of are either of the nature of epaulment or pit—more frequently the latter. A profile of the approved English gun-pit† is given in Fig. 1, and in Fig. 2, one blinded —such as might be constructed in the exposed parts of an entrenched position, time and means permitting.

Hasty cover for the infantry shooting line is provided by shelter trenches or breastworks; the former are sometimes, but not very often, blinded. Figs. 3, and 4, give profiles of English shelter trenches,‡ Fig. 8, of a breastwork. For protecting infantry supports, a trench, such as that of Fig. 5, or field casemate,§ as in Fig. 6, is usually made use of. For reserves, if entrenchments are necessary, field redoubts are generally employed; a profile, of common form, for a field work is shown in Fig. 7.

Having selected the particular entrenchments, it is next necessary to determine the distance of the spot from which the projectiles are to be supposed to be fired against them.

The general limits of range for ordinary artillery shell fire in attack are ruled by the considerations that guns should be brought into action within their effective range and not only so but, for decisive effect, at as short effective range as reasonably attainable.

Effective range of modern artillery is not limited by the power of the piece, but by the power of sight and observation of the gunner. Unless the object can be distinguished, it is ordinarily impossible to lay; and without observation of effect, correction, in order to good shooting, cannot be made. The state of the atmosphere, direction of the light, color, &c., will cause the limit of effective range to vary, but it may be set at the outside as 2500 yds.‖

---

* Case shot, being a defensive projectile for special occasions, we leave out of question.

† "In 1877-8 the Russians preferred fighting their guns on the surface, while the Turks commonly used sunken pits. Nearly all at Cerkovna and elsewhere on the Lom were of this form."—R.E. Prize Essay 1879, by Bt.-Major Fraser, R.E.

‡ "It may be safely said that the sections used in 1870–1 and 1877–8 were seldom as good, and in no cases simpler or better, than those in our latest text books."—R.E. Prize Essay 1879, by Bt.-Major Fraser, R.E.

§ "One of the chief lessons of the war of 1870–1 is the use that was made of blindages, or field casemates, for the supports, when exposed to heavy fire and when timber or rails were procurable." —R.E. Prize Essay 1879, by Bt.-Major Fraser, R.E.

‖ The effective ranges laid down for 16-pr. and 9-pr. M.L.R. in the rules approved for the umpire staff at the Aldershot manœuvres 1875, were respectively 2500 and 2000 yds.

The Prussian "Artillery Drill Regulations" state, "An effective artillery fire is not to be expected beyond 2625 yds."

The shortness of range attainable by artillery is governed by the consideration that, as far as may be, guns should not be brought within that distance at which they are likely to suffer very considerable loss, while coming into action, from opposing artillery in position; and, again, that they should, if possible, be outside the destructive zone of the enemy's infantry fire. With respect to the first-named condition, we find it stated,* that "the experience of the war of 1870–1 shows that the advance of guns into action at a mean range of 2000 paces (about 1670 yds.) can almost always be effected without considerable loss. This arises partly from the great mobility of the battery, and partly from the difficulty which the enemy will experience in firing at a long range against a moving object." From the war of 1876–7 we do not learn much in this respect, the Russians usually coming into action against entrenched positions at excessive ranges.† Taking into consideration that the French artillery was not up to the mark in 1870–1, and that since that time there has been nearly universal improvement in *matériel* and at the same time greater attention to practice, we incline to place the limit now at about 1850 yds. With regard to the limit of approach of artillery to hostile unbroken infantry, there is much variety of opinion: after the war of 1870–1 it was commonly fixed at about 1000 yds., since that time the Prussians have laid down that infantry may fire at artillery up to 1320 yds.‡ Due to improvements in small-arms and to the more careful and better training of the infantry soldier, in individual and mass firing, we think the distance of 1000 yds. may fairly be extended to 1300 yds. for the future.

The distance of about 1850 yds. from the main defences of an entrenched position will, then, ordinarily be the range at which artillery will come into action for definite attack; we shall therefore take it as the distance from which the projectiles are fired whose effect we propose to examine, and, unless the contrary is specified, we shall assume the ground to be level§ and the line of fire frontal.

To commence with the case of the ordinary breastwork; in Fig. 8, is shown the trajectory of a 16-pr.‖ common shell passing through the crest of the work: also the cone of dispersion¶ of a 16-pr. shrapnel burst 20 yds. short and having its trajectory somewhat raised above that of the common shell.

Bursting the shrapnel at greater or less distance than 20 yds. has the effect of increasing or reducing the section of the cone above the crest and the area of ground covered in rear of the parapet, at the same time reducing or increasing the velocity of impact of the bullets. Lowering the trajectory to that of the common shell—namely, till it

---

* "Characteristics of Modern Battles," translated from German by Captain Hime, R.A.

† To this there were one or two exceptions of coming into action at about 1800 yds.

‡ In the war of 1876–7 the Turkish unaimed infantry fire is stated to have had considerable effect up to 1700 yds.

§ Difference of level we need not enter into, the height of parapet being usually made to correspond.

‖ We take the 16-pr. as being the more powerful of the present English field guns.

¶ The drop of the axis of the cone we have neglected, as being of no practical importance.

passes through the crest*—the distance of burst remaining constant, increases the spread along the crest, diminishes the area of ground covered in rear and also reduces the angle of drop of the lowest bullets clearing the parapet.

If now the object of the entrenchment is to be nullified by destroying the parapet, clearly common shell must be the projectile used; and if by searching out and destroying the defenders, it is equally clear that shrapnel ought to be the projectile. The first idea may at once be set aside: for to destroy an earthen parapet to any sufficient extent with our present field service common shell (9 and 16-pr.) is impossible, the projectiles being deficient in the two essentials for such purpose—namely, penetrative power and capacity for bursting powder—† and even if replaced by still more powerful field shell,‡ the latter would yet be unequal to the task, unless a way is discovered of substituting gun-cotton, dynamite, or some such violent explosive for the present burster.

If the entrenchment is to be searched out by shrapnel, two points have to be fixed—namely, the best distance of mean burst from the crest, and the best height of the mean trajectory above it.§

There can be no question that it is preferable to burst the shell comparatively close, because the effect desired is not chiefly in depth or in height, but in width along the crest; and by short burst, the height of the trajectory being properly adjusted, the main number of bullets can be got to pass close to the crest, while, further, their striking velocity will be greater, enabling them better to work through the earth.‖ The best precise point of burst, as regards spread of bullets, it would not be possible to indicate unless we knew exactly the average dispersion of the bullets in a section of the cone; nor would it be any advantage to define it precisely, seeing that our present time fuzes are not adjustable to a short difference of distance: for example, at 1850 yds. range they do not permit of less increase or decrease in length of burst than 75 yds. Other advantages of close burst are that it causes the ground in rear of the parapet to be further and better covered by bullets, so interfering with freedom of movement for supports, &c., and that it enables the point of burst to be more readily judged of, for correction in firing. We therefore consider 20 yds. short to be about the best point of mean burst, but under this we think it should not be reduced.¶

---

* To lower it further than this would be unadvisable. (See after).

† We have no results of experiments on this head to refer to, but the following is given in the Prussian "Artillery Drill Regulations" for German guns:—"Tegel, 1876. Penetration into sand parapet by both light and heavy field common shell, at 437 yds. range, 39·4 ins.; crater 19·7 ins. deep, 59·0 ins. broad and 59·0 ins. high."

‡ Probably the 13-pr. under trial will give satisfactory penetration.

§ When shrapnel is burst by percussion fuze, its effect, even under favourable circumstances, is very much reduced, from the diminished velocity and angle of ascent of the bullets after graze of the shell: we therefore set it aside in the present question, as unsuited and inferior to time shrapnel.

‖ A few inches of earth, however, suffice to stop shrapnel bullets.

¶ Bursting 20 yds. short gives a diameter of cone at the crest of 9·4 ft. The Prussian "Artillery Drill Regulations" recommend 27 yds. and under, as the best distance of burst.

With regard to the height of the mean trajectory, in order to obtain an increase rather than a decrease in the angle of drop of the bullets, as well as to avoid losing the greater number of the latter in the parapet, the lower half of the cone should be made use of—that is, the mean trajectory must pass above the crest and, in order that the cone may reach the latter, within a distance equal to the radius of the cone at that part. Bearing in mind what has already been said on the subject, it seems best to make a compromise between length of spread along the crest and loss in bullets and in angle of drop and to fix the height of the mean trajectory at one-fourth the diameter of the cone over the crest, as shown in Fig. 8.*

But with such—as we believe the best—application of shrapnel, can the entrenchment be considered sufficiently searched out? Certainly not; for the lowest bullet would pass over the head of a man 6 ft. high, standing in the trench—in fact, but men actually firing could be touched, and to protect these a bonnette with loopholes could readily be formed of sand-bags, &c., against which shrapnel would be powerless and which would have the further advantage of increasing the shelter in rear.†

Would, now, common shell, though not the natural projectile, so to speak, avail any better than shrapnel for searching? From the great spread of its splinters it doubtless would, providing only it could be burst about the crest, otherwise, due to the small number of fragments and their irregular dispersion, the effect would be insignificant. Would it, then, be practically possible to obtain a sufficiently regular burst about the crest to be effective, using either time or percussion fuze? We think not: for if the latter fuze was used, only shells striking within about a yard of the crest, or on the bonnette, if there was one, would be effective—in fact, the mean trajectory should pass through the crest, as in Fig. 8; all others would either be lost in the parapet, or, clearing it, would drop too much to the rear to have any immediate effect; and if time fuze was used there would be even less chance of result, for the fuze, as before mentioned, does not admit of nice adjustment to distance and therefore it might be impossible to hit off the burst within the narrow limits necessary for effect.

Against the breastwork the effective power of field projectiles therefore stands thus: shrapnel has no real searching power, not even against defenders actually firing, if the latter are protected by a bonnette, but it covers the ground at some distance to the rear well; common shell may have an imperfect searching effect, but with wasteful expenditure of ammunition; it will, however, destroy the bonnette and reduce the crest.

---

* The mean trajectory thus passes 2·35 ft., approximately, above the crest, the point of burst being 7 ft. 6 ins. above the plane of the latter.

The Prussian "Artillery Drill Regulations" lay down that shrapnel should be burst 7 ft. to 10 ft. above the crest; which, for the distance of burst and angle of descent we have taken, would give the mean trajectory passing from 1 to 4 ft. above the crest.

† Increasing the range would, of course, increase the angle of descent of projectile and bullets, but such increase would not be sufficient to counterbalance consequent disadvantages—as loss of velocity, facility of observation, &c.

Such being the case, the proper method of proceeding surely is to use common shell with percussion fuze first, to prepare the way, as far as may be, for shrapnel, and then the latter with time fuze to deal with the defenders, particularly when firing and also to impede movements in rear.*

If now the line of fire be taken oblique instead of frontal, the consequence will be that the projectile becomes opposed by a greater thickness of parapet,† while its angle of descent behind the latter is practically increased. Thus, a projectile coming from the front, from a spot 1850 yds. distant and passing through the crest with 5° 5′ angle of descent, would have the latter in effect increased to 7° 10′ if, the range remaining the same, the line of fire was taken 45° oblique; and, if it passed through the parapet, it would have 9·9 ft. of thickness to penetrate instead of 7 ft. It must also be borne in mind that making the line oblique‡ and keeping the range, as before, at 1850 yds., necessitates the gun being brought to a distance of 1308 yds. from the prolongation of the breastwork—that is, possibly nearer the enemy's shooting line.§ Keeping in view the action and possible application, already mentioned, of common shell, there would not appear to be any advantage in taking an oblique line of fire when using it, but rather the contrary. With shrapnel, however, if circumstances do not necessitate too much increase of range, an oblique line will be advantageous, not only in increasing the drop of the bullets, but in keeping their spread more in the direction of the line of the parapet.

The method of attack which thus appears best suited to the breastwork will evidently be equally applicable against the field redoubt (Fig. 7), the profile of which is similar. The searching out of the redoubt, from the better cover which it affords, will naturally be more difficult, at the same time that a thicker parapet and probably more carefully prepared defences will oppose greater resistance to projectiles; hence, there will be need for longer preparation by common shell in opening the way of shrapnel. In works of this type we also expect to find large use made of overhead cover, such as blindages; against this gun-fire, as was seen in the war of 1876–7, is of no avail, and, indeed, could not be expected to be: for, in the first place, the low trajectory of projectiles fired from guns forbids, in general, their reaching such cover, and, again, even if they reached it their mining power is too insignificant for real effect.

Taking next in order shelter trenches for the infantry shooting line, and supposing them fired at under the same conditions and in the same manner as the breastwork, we have the descent of the lowest bullet which passes‖ the covering earth, as shown in Figs. 3, and 4. It will

---

* Trajectory, &c., of shell as shown in Fig. 8.

† The defenders constituting but a line, as it were, can hardly be said to be taken in greater depth.

‡ The objection that taking a target obliquely makes it of smaller width for laying on and hitting does not, of course, apply to a length of parapet.

§ If the line of fire was made 45° oblique, and frontal distance kept at 1850 yds., it would have the effect of increasing the range to 2616 yds.

‖ A few inches of earth, as before mentioned, are in general sufficient to stop a shrapnel bullet.

be seen that neither trench is completely searched out, for in one a man would be safe lying down and in the other secure sitting; when firing in either trench he is of course partially exposed. If, however, common shell with percussion fuze* be used, the trenches may be completely searched out, as they are shallow and the protecting earth is not of sufficient thickness to keep them out, or even many of their splinters if they burst in that earth.† In order to ensure full penetration, as well as to secure a maximum number of effective hits, the mean trajectory of the shell should strike a little above the centre of the covering earth, as shown in Figs. 3, and 4. We therefore advocate for the attack of such trenches common shell with percussion fuzes, in the first instance, then time shrapnel when the protecting earth is cut down or the infantry fully committed to firing. In using shrapnel the point of mean burst should be rather longer than when firing against a breastwork or parapet, the cover being less, as well as more easily reduced by common shell. If, however, the trench is blinded, common shell must be adhered to throughout, though it is not likely to give much result.

Against field casemates and also against open trenches for supports (Figs. 5, and 6,) the same rule will apply as to the blinded trench.

With the foregoing entrenchments, as in the case of the breastwork, an oblique line of fire with common shell is to be avoided, but with shrapnel may be advantageous.

Lastly, we come to entrenchments for artillery. In gun-pits (Figs. 1 and 2), or any form of battery for field guns, plainly the gun and gunners, while actually working must be more or less exposed, and when not working the gunners' case is similar to that of infantry behind a breastwork. To open out the embrasure, remove any protection such as logs, fascines, &c., placed across the upper part of it or upon the parapet, as well as to cut down the crest of the latter, common shell with percussion fuze, as in former instances, should first be used, thus preparing the way for time shrapnel, which should after take its place. If the entrenchment is blinded, common shell alone must be used, as with other cover of that nature. The rule already given for taking an oblique line of fire will hold good with gun-pits, &c.

We thus find as a general rule, to which there is one exception, that in the attack of field entrenchments by artillery, the object of the former must be nullified partly by destroying and partly by searching out, fire being opened with percussion common shell, and changed to time shrapnel as soon as the cover is somewhat reduced and the defenders fully committed to firing.‡ All nature of blinded cover and the deep

---

* Time fuze we reject for the reasons before given.

† The burst, we know, though apparently instantaneous on impact, is not really so, and therefore would usually take place towards the inner side of the covering earth; due to which, and to the onward velocity of the splinters, the main effect would be spent in the trench.

‡ Since writing this essay it has accidently come to our knowledge, that experiments have recently been made as to the searching power of Gatling guns, fired at 2500 yds. range (and therefore with considerable elevation), and apparently with good result. We however question the efficacy of such fire, under service conditions, at the long range necessary to obtain a sufficiently

trench for supports form the exception to the rule, percussion common shell alone being applicable against them; though, in the present state of field artillery projectiles, it can be with little promise of success.

We have pointed out, with regard to frontal and oblique line of fire, that with common shell the former is most advantageous, but with shrapnel, if circumstances permit of it, the latter; it remains now to make a few remarks upon enfilade and reverse fire. From the great extent of modern positions, the opportunity for such fire will seldom be presented; when it is, unless the entrenchment is well protected by traverses or parados, it must be open to be fully searched out and if so, evidently, time shrapnel is the proper projectile, and should be burst according to the ordinary rules for its use in the open. If the entrenchments are traversed, the same rules will apply as laid down for frontal fire. Even if a work is traversed, &c., there is an advantage in enfilade and reverse fire over frontal, in their greater moral effect and in their taking the defenders in a direction in which they cannot so readily reply, while, further, in the case of enfilade fire the target is taken in its greatest depth.

From what has been said on our subject, the following deductions may be made:—

For the attack of entrenchments, more particularly of hasty entrenchments in which the thickness of the covering earth is limited, the shell thrown from field guns should have as high remaining velocity as may be* at ordinary fighting ranges, so that they may be able to pass through as great a thickness of earth as possible, and deliver the bursting effect for the most part on the inner side of it.

For the attack of entrenchments of strong profile, also of field casemates and other blinded cover, in order to their sufficient searching out, pieces throwing powerful shells with high angles of descent are necessary—in other words, field howitzers.†

The limits of effective strike of percussion common shell being in all cases very restricted, it is absolutely necessary that the guns throwing them should be very accurate in their shooting,‡ and it is hardly necessary to mention that in order to utilise such accuracy to the full the gunners must be accustomed to lay upon and observe the effect of shell fired at entrenchments.§

---

high angle of drop for searching—while, even if the fire was hurtful any slight over-head cover would nullify it.

It is a pity that the results of such-like instructive experiments are not made more public to the Regiment; if they were so, it would tend much to increase the desire for and the attainment of practical technical knowledge.

* This, it is hardly necessary to say, is a desideratum when firing against troops in the open, and in the later field guns has been much increased—that is, in the experimental 13-pr. and in the sometime approved foreign guns.

† Such pieces would be equally useful to the defence for searching out natural cover taken advantage of by the assailant and, also, in the close attack for sweeping the ground with large shrapnel.

‡ An additional reason for high velocity.

§ To assist their vision in laying, Nos. 1 might carry in a pocket on their belt a telescopic magnifying glass, 2 or 3 ins. in length and for use rest it against a shoulder formed on the tangent sight. A regular telescopic sight we consider unfit for ordinary purposes, though it would be useful on special occasions.

A time fuze admitting of adjustment to small difference of distance is desirable.

With reference to the desirability of high remaining velocity in projectiles, we would draw attention to the fact that our present field guns—9 and 16-pr.—are very much wanting in velocity and accuracy,* having long since been surpassed by the field guns of almost every other nation, though at the time of their introduction they were second to none. The 13-pr. now in progress bids fair to make good this deficiency in part, by replacing the 9-pr., could the equipment only be completed;† but what have we, even on the way, to take the place of the 16-pr.?

As to the introduction of field howitzers, it would be but a return to the organisation of the S.B. system, which was the outcome of long experience and would, in fact, be but amending an oversight made on the introduction of rifled ordnance consequent upon the transcendant power of rifled guns as compared to S.B.‡

II.—The Attack of Field Entrenchments as a Question of Tactics of the Unit.

In examining this question we have to determine, first, the best position into which the battery, or unit, can be brought for attack; then, what is necessary to be done previous to opening fire; and lastly, how the fire is to be conducted when opened.

We do not propose to enter into a discussion of the general requirements of the position for a battery,§ nor how particular circumstances may affect its selection, but simply to point out the *direct* conditions which, as far as possible, should be complied with in choosing a position, in order to secure maximum fire effect against an entrenchment.

We have already said that in the attack artillery ranges cannot generally be less than 1850 yds. when opposed by unsubdued artillery and 1300 yds. when by unbroken infantry. So far as circumstances admit, these limits should in the first instance be approached to, or the greater reduced, in order not only to obtain high velocity of impact, &c.,‖ of the projectile, but to secure facility of laying and observation of effect. To seek to diminish the range under about 1300 yds. is, however, not required and would practically yield at such short distance but insignificant further increase of effect. When an action is opened at or about the longer limit of range, it is undoubtedly necessary, in order to final and decisive effect, when the enemy's artillery fire has been weakened, to advance to the nearer limit.

---

* Other objections—as relative weight of piece and projectile—might also be urged.

† It has now been five years at least in progress.

‡ It has already been found necessary to introduce rifled howitzers for siege purposes; and the use of entrenchments on the field of battle tends to assimilate battle and siege: in fact, as at Plevna, the assailant may have to become a besieger.

§ For these, see "Minor Tactics," by Captain Hime, R.A., the R.A. Prize Essay, 1871.

‖ The consequent lesser angle of descent we hold to be of no moment.

The best line of fire has also been indicated. The fact that an oblique line with common shell is not advantageous, while the contrary holds good with shrapnel, is conflicting, if both natures have to be fired from the same position; but, if such is the case, that line should be taken which, other things equal, is most suitable for the projectile mainly demanded by the circumstances of the time. It is certain that it would never be worth while to incur the disadvantages which change of position usually entail simply for the purpose of changing the line of fire from frontal to oblique for shrapnel—a projectile which has such an extended area of effect. No advantage can be got by crossing the fire of the guns of a battery, with the view of obtaining an oblique line; the degree of obliquity so obtained, even at short ranges, being insignificant, while confusion in observation of effect may be the consequence.

It is desirable that the attacking guns should have some command over the entrenchment, as observation of effect will be assisted thereby;* but too great difference of level is to be avoided, as it may have the practical effect of sensibly reducing the height of the target, which will be the more felt when the entrenchment is above the level of the guns, as then it may fall out that, due to the height of his position, the defender has not been obliged to throw up as high a parapet as ordinary.

The ground selected for the guns should, if possible, be fairly even and not too soft, to permit of their being easily worked and readily laid.

That position which affords the best combination of the foregoing conditions of range, line, and ground—special prominence being given to the first—will be the best for fire effect and should be occupied, unless wanting in some ordinary quality of an artillery position of essential importance at the time, or, in respect to those qualities, some very decided advantage renders another position, perhaps not quite so good for fire effect, very desirable. To take in quickly the circumstances of the individual case and strike a balance between advantages and disadvantages, giving due prominence to those which at the time either are, or may prove, the most telling, requires in the commanding officer of a battery an experienced eye, as well as sound and ready judgment.

The position having been selected and having been well reconnoitred by the officer commanding the battery, he should bring his battery into it, if possible, without detection by the enemy, in order, among other things, that he may secure the initiative of fire—which, besides yielding a moral as well as practical advantage, is the more necessary for him as he has to find the range, already most probably known to the enemy. In disposing the guns in the position, they should be placed to the best advantage as regards suitability of the ground for working them, possibility of covering them, &c., without reference to interval or line, providing only that their connection, as parts of the unit, under the commanding officer be not severed.

---

* It also assists covering the guns.

While the battery is coming into position for action, the range to certain points of the entrenchment should be accurately taken by the range-finder, the N.C. officers appointed to use it having accompanied the officer commanding in his reconnaissance and having received definite instructions from him. If, however, a range-finder is not available, the range must be ascertained by the system of trial-shot firing,* and even if accurately measured by the range-finder, it requires to be checked by this system; because, due to variation in the quality of the ammunition, &c., the range of the projectile, however accurately the piece may be laid, may not correspond to that to which the sights are set.

The range may be considered to be obtained, or, in other words, the mean trajectory assumed to pass through the point aimed at, when half, or at short range less than half, the projectiles are "under."

Satisfied that he has obtained the range, the officer commanding has then to regulate the distribution, or otherwise, of fire, adhering to the conditions regarding projectile, &c., laid down in Part I.

Concentration of fire is, we know, necessary to decisive effect; supposing, therefore, that gun-pits form the target, the whole fire of the battery should be directed successively upon each pit until the gun in it has been silenced and the pit ruined. This mode of proceeding is further necessary as, due to the relative lie of the entrenchment and the battery, the range may not be the same to each pit, and it would be very inconvenient at the least, to take up several ranges at the same moment. If a line of infantry in shelter trenches, &c., is the object, not being so formidable for reduction as the preceding, the same amount of concentration is not required; therefore, instead of the fire being confined, as it were, to points, it may be extended to lengths in succession. The particular length taken by a battery should, we think, about equal its front,† or in round numbers about 100 yds.; this must, however, be partly dependent upon the total length of the entrenchment, as it should be equally covered by the guns, without—if we may so describe it—leaving a fractional part for the fire of all the guns to be finally overcrowded upon, or for some guns only to deal with.

The fire of the battery should be carried on regularly and deliberately from flank to flank; hurried fire, with hasty and imperfect observation, can never be effective and independent firing is, in our opinion, to be deprecated, unless very special circumstances call for it, as it removes the power of proper supervision and ordering from the commanding officer and tends to permit undue haste.

When the fire of a battery is changed, while in the same position, from percussion common shell to time shrapnel, the correct distance of

---

* See "Manual of Siege and Garrison Artillery," 1879, p. 32. In this trial firing each gun should be laid on the same point—such as the crest of the parapet at one flank, or a flank embrasure, to which the range has been taken, as named by C.O.; each No. 1, checked by his divisional officer, giving the particular deflection required by his own gun.

† The Nos. 1, trained to this length, on the command "Distribute the fire," would readily take up that point of the object distant the proper space for his gun from the point to which the range was taken, and on which probably the flank gun would continue its fire.

mean burst of the latter has to be obtained and can most readily be found from the known range, as basis, by trial shell.* At the same time, as we have seen, in all cases the mean trajectory should be raised slightly above that of the common shell—an alteration which should be effected by means of the sights.

When it is desired, as it may be from a near position, to employ time shrapnel at once on coming into action, we would still advocate ascertaining the range correctly with the assistance of percussion common shell, and proceeding as above, because of the great difficulty of otherwise hitting off the correct range, height of trajectory, and distance of burst at once, due to the difficulty of accurately judging the point of burst of time shrapnel; while the power of the shell being restricted by the cover, there is the more need for its being burst at the most suitable point.

In carrying out the foregoing programme of firing, after taking up position for action, the effect will, in the main, depend upon the ready and correct use of the range-finder in the first instance, then upon the commanding officer's correctness of judgment and observation and finally upon the divisional officers and Nos. 1 carrying out his orders strictly and with intelligence.

We have already, in Part I., adverted to the necessity for these latter being practised in firing at entrenchments, in view of accurate shooting on service; we would now further advocate the same on the ground that they might be able, from their own individual technical knowledge, fully to grasp and hence, without doubt or hesitation, carry out their orders. And even much beyond this we would go, and insist upon the practical training of the commanding officer in such firing; that he, upon whom so much depends, might be fully equal to the occasion. Of late years much has been done in the right direction in providing land ranges for some of the field artillery annual practice; but, we believe, there is still too much adherence to the time-honored $6' \times 6'$ target,† and too little approach in dummies‡ placed in entrenchments (also behind natural cover and in the open) to service conditions, while the officer commanding the battery never has the opportunity of applying and ordering the fire of his battery, as he would have to do on service. As part of the annual practice of a battery, it should be brought into action against dummy guns and gunners in gun-pits,* dummy infantry, lying down, firing, &c., in trenches and behind breastworks,§ at unknown ranges, without any communication with a range-party and fire a certain number of rounds of each kind of shell, when the result should be carefully examined and noted by an umpire.‖

---

* See "Manual of Siege and Garrison Artillery," 1879, p. 31.

† Such is, of course, necessary for first training.

‡ Dummies should always be painted the correct colours; not white, or left plain, which renders them more conspicuous than true.

§ Also dummies behind natural cover and in the open.

‖ The results of this firing of the different batteries—taken, as far as possible, by the same umpire—should be tabulated and published in regimental orders. The figures would represent the *bonâ fide* value of the batteries in one of the highest qualities necessary for service.

We feel certain that the smallness of the result, in nine cases out of ten, would be astonishing; for perfection of fire is not to be learnt by intuition in any number of years of ordinary routine, as the French found to their cost in the war of 1870-1. Autumn manœuvres—very necessary for many reasons—cannot assist in acquiring shooting power; for this we can alone look to careful preparation in the battery drill-field and then to the annual practice, but to make the latter answer its proper end in this respect the present system requires remodelling.*

But to pass to other points, admitting that the present range-finder is all that can be desired (which, however, we are much inclined to doubt), it requires, for its ready and correct use, men who have been carefully instructed to use it and, not only so, but kept constantly habituated to its use. Now, what provision is made for this? Simply none at all; the range-finder is handed over to some one or two junior N.C. officers of the battery who have used it once or twice during a course of gunnery instruction at Shoeburyness and no horses are allowed for the purpose of mounting them.† There can be no question but that obtaining the range quickly and accurately is of the greatest importance, for every shot fired until this is done is so much ammunition thrown more or less away; hence provision should be made for the effectual use of the range-finder, in which view we would suggest that in each battery two selected N.C. officers should be trained for the purpose, distinguished by a badge, and horses provided to mount them.

Accurate observation, especially on the part of the officer commanding the battery, preparatory to and during firing we have seen to be very necessary; but this cannot be attained without the aid of a good field-glass. For service, every officer is recommended, or supposed, to provide himself with one; but in peace—which should be preparation for war—nothing is laid down on the subject. We think such a necessary article ought not to be left optional, and we suggest that the present pouch of artillery officers might well be replaced by a case carrying a small and powerful glass.‡

Range cards (waterproofed) giving lengths of fuze, &c., should be provided for all officers, that they, and especially the commanding officer, may have ready to hand the information they may require, without having to go to the range plate on the carriage for it.

It is very desirable that the probable rectangles of field pieces at ordinary ranges should be published, that officers might know what

---

* The system, that is, as carried on at standing camps. With regard to annual practice of field artillery over sea ranges (to which half, or even more than half, the horse and field batteries at home are condemned), we can only say that it is an absurdity, being a waste of ammunition, except so far as to decide the prizes for skill at arms, or teach the preliminaries of gunnery to unskilled men.

† Two spare riding horses only are allowed to each battery; but these are to cover casualties, and if not so employed are taken up by the Rough Rider and 2nd Trumpeter.

‡ For war, the ordinary pouch-belt—or, as it then would be, the field-glass belt—might be replaced by one doubled and stitched to receive revolver ammunition.

their guns could do, and therefore what they should do, in point of accuracy in the hands of their men; but as it is at present they have no standard with which to compare. Again, if it is desired to raise the point of incidence of the trajectory of a projectile a certain vertical height on a target, there is no table to show how much to alter the tangent-sight. Surely the "Manual of Field Artillery Exercises" should contain these and all necessary tables of reference, and not only so, but all technical information tending to instruct the artillery officer in the scientific use of his weapon and the proper tactical application of his arm; but, as it now stands, the book consists of little more than details of drill, which, though necessary for training, are but the first stage towards effect on service.

III.—The Attack of Field Entrenchments as a Question of Tactics of the Mass.

In treating of the attack of an entrenched position—as, in other words, our heading might be stated—we shall assume, in order to fix our ideas, that the attacking force is an army corps and that, the enemy's advanced posts having been driven in, he is "contained" within his position.

From the range and power of its projectiles, artillery must ever prepare the way for the advance and assault of the infantry. Hence the arm has, in the first instance, to subdue, and if it may be silence altogether, the artillery of the defence, covering at the same time the deployment of the infantry; then, to destroy the defences and artificial obstacles of those spots selected for assault and to disorganise the infantry defenders.

The officer commanding the artillery, having accompanied the General in his reconnaissance and having been made acquainted with the points of attack and general dispositions, communicates any particular information he thinks necessary to give to the commanders of the divisional and corps artillery. The latter commander remains with him and receives his orders direct from him, while the former receive their orders each from the General commanding his division, whom he accompanies in reconnoitring the attack appointed to the division, and with whom he determines the position which the divisional artillery is to take up.

In selecting this position a few general conditions, over and above those already mentioned when speaking of the unit, have to be kept in view—namely, as follows: the artillery should be so placed that its fire may not be likely to be masked by the infantry advancing; the arm should be in tactical connection with the latter, yielding to it not only the necessary physical but moral support; its units, separated if need be, in order to take full advantage of ground, line, &c., should not be so dispersed as to sever their union under the divisional commander. The first of these conditions points to placing the artillery on the flank*

* And slightly in advance, to cover the deployment.

of the ground on which the infantry will deploy, as well as to the position having command over the entrenchments, which latter, as already stated, is to be desired for other reasons; the second, to the necessity for change of position from that first taken up to one at short range, a condition already mentioned as necessary for decisive effect—on occasions, to within even less than 1300 yds. of the entrenchments, for full moral support.

The position for the divisional artillery having been thus determined, officers commanding batteries receive their instructions from their divisional commander, as fully as may be, not only as to position, attack, &c., but as to the ends in view. In general the batteries should not be brought into the position sooner than necessary for opening fire at the time ordered, but should remain near wherever they can best be covered and any time available employed in preparing the position by digging gun-pits, &c., if it can be done without attracting the enemy's attention.

In telling off the batteries to their respective posts in the position, the light battery should be placed upon the more exposed flank, so that, if required,* it could change front to resist a flank attack while the heavy batteries continued their fire against the entrenchment. This battery should also, if possible, have a weaker, or a less extensive part of the entrenchment than either of the latter apportioned to it as its object of fire. In appointing the latter the divisional artillery commander must regulate the concentration of fire as he thinks advisable, but each battery should have its own individual object, or part of the entrenchment, to prevent confusion in observation of effect and consequent difficulty in obtaining accurate fire; the amount of concentration being arranged by the degree of closeness of the separate objects or portions.

The batteries of the division should open fire simultaneously, in order to secure superiority of fire; and having opened fire, the ordering of it should remain in the hands of their respective commanding officers, until a change of object, or position, is ordered.

We may here note that, as in the case of the divisions or half-batteries of a single battery, no advantage is gained by crossing the fire of a division in line against an entrenchment in the view of obtaining an oblique line, though, of course, the obliquity obtainable will be greater than in the case of the single battery.

From the successful manner of employment of the German artillery in the war of 1870–1, it has come to be generally accepted that "the entire artillery of the main body ought to be brought up at the very commencement of an attack and all the guns brought into action at once;" the object assigned for this procedure being to prevent the enemy destroying the attacking artillery in detail as it comes up and also, by numbers and concentration of fire, to obtain superiority of fire as early as possible.

We agree with the desirability of the latter and that all proper

---

* Part of the reserve would, in general, ward off such flank attack.

endeavour should be made to attain it, but we cannot admit that the above is the correct manner to secure it, for the following reasons, namely:—Forming up a comparatively large mass of artillery from column of route takes time and extends over considerable ground, hence, the main body of the infantry being to the rear, the mass can be but inadequately protected and therefore offers an opportunity* for striking a severe blow which an energetic defender is not likely to let slip;† it is hazardous not to retain some artillery in hand to meet critical and unforeseen circumstances, and even though it may be possible to withdraw a part from action for a pressing new application, yet it may be a matter of some difficulty and must certainly be so of time more or less—which is usually an element of all importance—while the aid thus brought cannot be so effectual as that of fresher troops; it may, from the extent of its continuous line, delay unduly the deployment of the infantry and cause them to have greater distance to traverse, not only previous to deployment, but in their after advance, and also in the latter to mask quickly some of the guns; it facilitates, in the massing which it entails, the concentration of fire and consequent effect of the artillery of the defence; it will not, in general, permit of the guns taking advantage of the ground most suitable for them as positions; it is exposing the whole of the General Commanding's hand, tying him down to a certain line of action and using the arms of the service abnormally in applying them independently instead of in combination; it is not necessary in order to prevent the enemy destroying in detail the artillery of the attack as it comes up, because the first position for the latter is so chosen as to be, as far as possible, beyond that range at which it is likely to suffer serious loss in this manner, while natural cover will probably be available and, if not, artificial may be thrown up, while, further, in the attack of an entrenched position, as already mentioned, guns should not be thrown forward till required to open fire and fire should be opened simultaneously and not independently; nor is it necessary in order to concentration of fire, for this can usually be better obtained without concentration of guns, adapting the position of each battery, or division, to the particular object, or objects, of fire appointed it.

We would therefore advocate the divisional artillery of the attacking divisions coming into action, to fulfil their *rôle*, locally with their divisions; then the corps artillery and the artillery of the division in reserve, supplementing them against the most decisive point, or points, —which become more evident as the engagement proceeds—and also acting as reserve proper.

The corps artillery of a British army corps is laid down to consist of two 16-pr. field batteries and three 9-pr. horse artillery batteries, and the artillery of a division of two 16-pr. and one 9-pr. field battery. It is clear that of these the lighter and more mobile batteries are the more proper ones for discharging the chief duty of true reserve—namely,

---

* This is the more apparent when we consider that with modern arms it takes but a short time in the close fight to decide the question of success or reverse.

† See on this subject R.A. Prize Essay, 1876, by Colonel Smyth, R.A.

making flank attacks, which may necessitate long detours, manœuvring to resist counter attacks or to meet the necessities of critical moments. Again, it is generally allowed that the divisional artillery should form an intimate part of the division to which it belongs and act with it; hence it follows, taking the batteries as above, that the three horse artillery batteries would best form the reserve artillery proper and forming it should be attached for the time to the division in reserve, the heavy batteries of which would be better attached to, and utilised with, the corps artillery against the decisive points of the entrenched position.

As soon as the artillery of the defence has become somewhat subdued, and the infantry of the attack sufficiently advanced, the batteries must be moved forward to their second* position. This should be by successive batteries, those being first pushed forward whose fire has become of less consequence, or of less efficacy, in the original position. Endeavour ought, however, to be made to throw forward some of the heavy batteries early, not only because of their greater power against infantry, but to subdue guns of the defence hitherto unsubdued—perhaps undiscovered—which might seriously impede the further advance of the infantry.

From the first position of attack the fire of the batteries against the entrenchment will mainly consist of common shell; but from the second, the defences being partly reduced and the infantry defenders continuously firing, will be the opportunity for shrapnel and for taking an oblique line of fire—the latter not only increasing the fire effect of that projectile, but suiting the placing the guns on the flanks of the advancing infantry, so that they may not be masked by it.

Immediately preceding the assault, the fire of the batteries should be as quick as it can effectively be, and as soon as it becomes masked by the infantry it should be turned upon the enemy's reserves, or, if need be, to repulse any counter-attack.

Should the assault be successful and the entrenchment occupied, some guns of the reserve should be advanced into it, in order to securing it.

We need hardly mention that it is essential that a perfect supply of ammunition be kept up to the gun-limbers during the action.

In conclusion, we would make a few observations. First, with regard to the proportion of horse artillery. Three batteries are allowed to the corps artillery, which, as we have already stated, would naturally be employed in flank attacks, resisting counter-attacks and supplying aid at critical moments; in all which purposes time comes in as an element of the greatest importance, and hence speed may be required, while the distance to be traversed may be comparatively long. Notwithstanding such conditions, we are of opinion that horse artillery is not, in general, required for these duties, but that light field batteries are sufficient; because the latter are more mobile than infantry, though not so much so as cavalry and because further, it is neither necessary nor desirable now, in the days of rifled arms, to approach to such close range of the

---

* More than one change of position may, of course, be necessary.

enemy as formerly in the time of smooth-bore arms. Two exceptions, however, must be made in favour of the employment of horse artillery—namely, when the batteries have to act in concert with cavalry and when they have to act independently with the utmost speed, as, for instance, when bearing aid at critical moments. For the former—which is the true purpose of horse artillery—there is the horse battery of the cavalry brigade and for the latter—which would be of rare occurrence—one horse battery in the corps artillery would suffice; we therefore conclude that two horse artillery batteries of the corps artillery might well be replaced by two light field batteries.* In this we are assuming that, as at present, both horse and light field battery are armed with the same gun, the propriety of which cannot be doubted; for, apart from other considerations, the additional weight of 5 cwt., due to the three extra men mounted on the carriage, brings up the weight behind the team of the light field battery to quite as much as is admissible.

In Part I. we have shown the necessity for the introduction of field howitzers for the attack of entrenchments. Such pieces should be disposed in batteries, not as they were in the S.B. system mixed with guns in the same battery, which tended to complication and confusion, besides preventing the use of the full power and proper application of both descriptions of ordnance at the same time—one being, as it were, tied down by the other. It appears to us that it would be well if the two 16-pr. batteries of the corps artillery were replaced by heavy field howitzer batteries,† for special use against the decisive points of attack.‡

As in Part II. we adverted to the need for systematic and practical annual practice in order to effectual training of field artillery, so now we would lay stress upon the absolute necessity for autumn manœuvres, or combined exercises on not too small a scale, in the same view. Without such regularly—not incidentally, once in a way—how can officers commanding divisional artillery, or batteries, be habituated each to perform his own proper part in the chain of responsibility towards a common end, and more especially in taking up proper positions, with reference not only to fire effect but to combined action with other arms? Proper and ready choice of position is, as we have already stated, difficult; not so much in satisfying the ordinary desiderata in detail of ground, as in proper adjustment to circumstances of the moment. Hence nothing but practice in dealing with circumstances as they arise can give the power and confidence necessary in order to right selection.

In conclusion we would note that the terms "reserve" artillery and "massing" guns seem now frequently used in an uncertain sense and it appears desirable that definite meanings should be attached to them. For example, the former term is frequently applied to the corps

---

* And for all field service, not merely the attack of an entrenched position.

† The construction of this equipment would be guided by the consideration that the total weight behind the team should be the same as the heavy field batteries—*i.e.*, the maximum admissible for field service. A light field howitzer we consider unnecessary.

‡ They would be equally useful for defence, to search out artificial cover, hollow ground, &c., as already mentioned.

FIG 4.

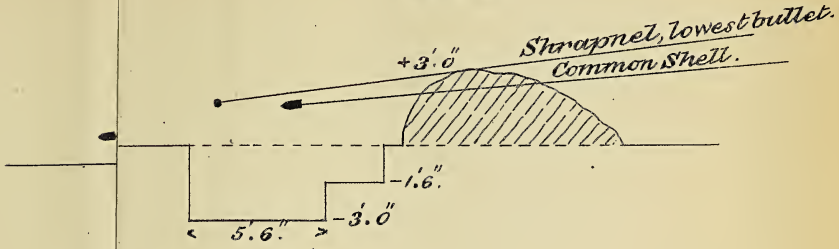


FIG 5.

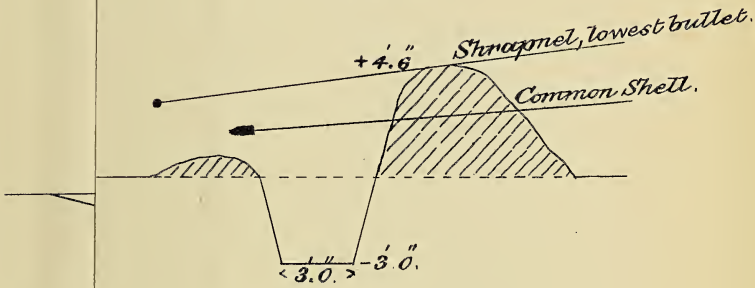
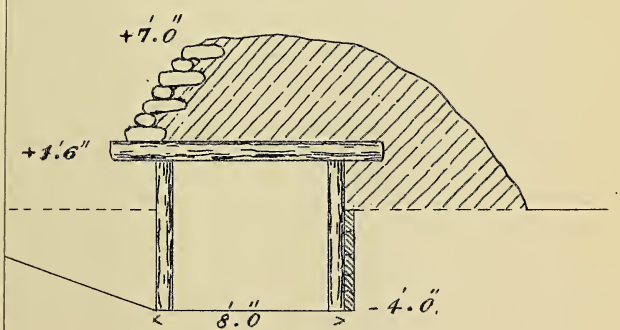


FIG 6.



Scale $\frac{1}{8}$" = 1'

FIG 1.

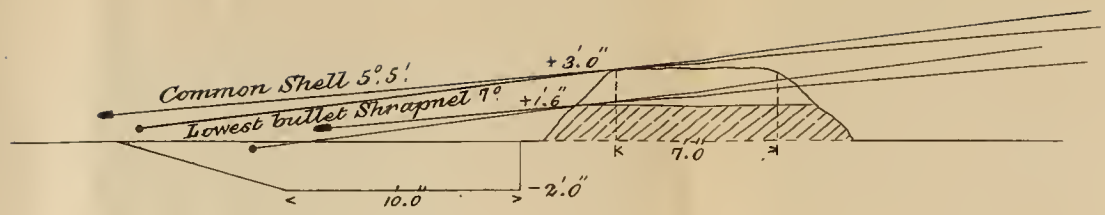


FIG 2.

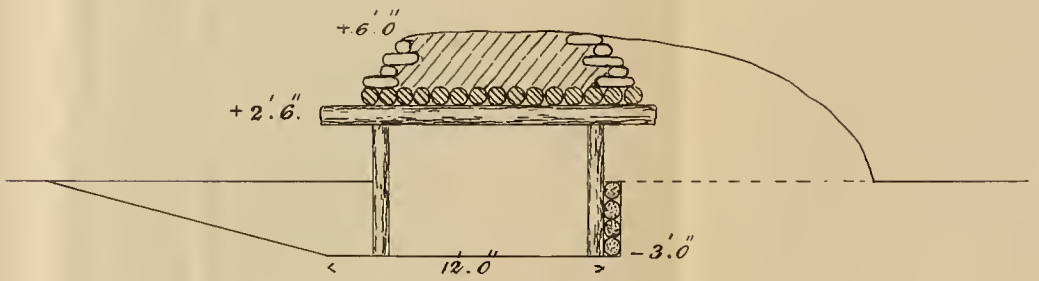


FIG 3.

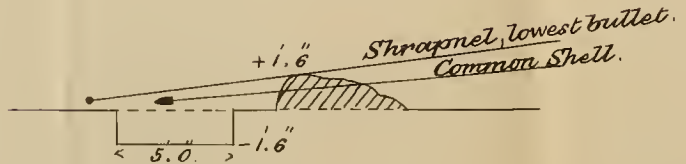


FIG 4.

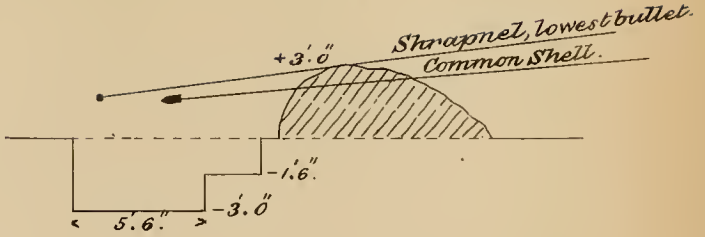


FIG 5.

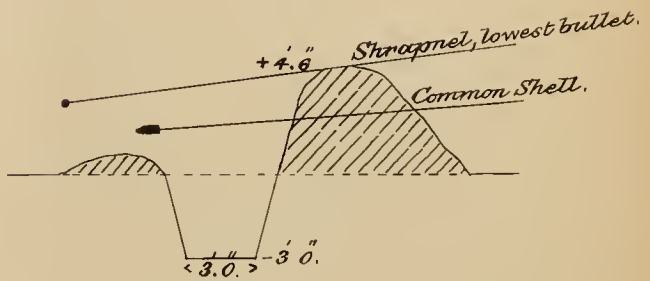
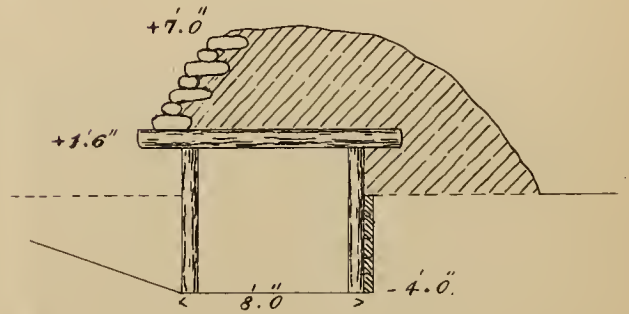


FIG 6.



PL. II.

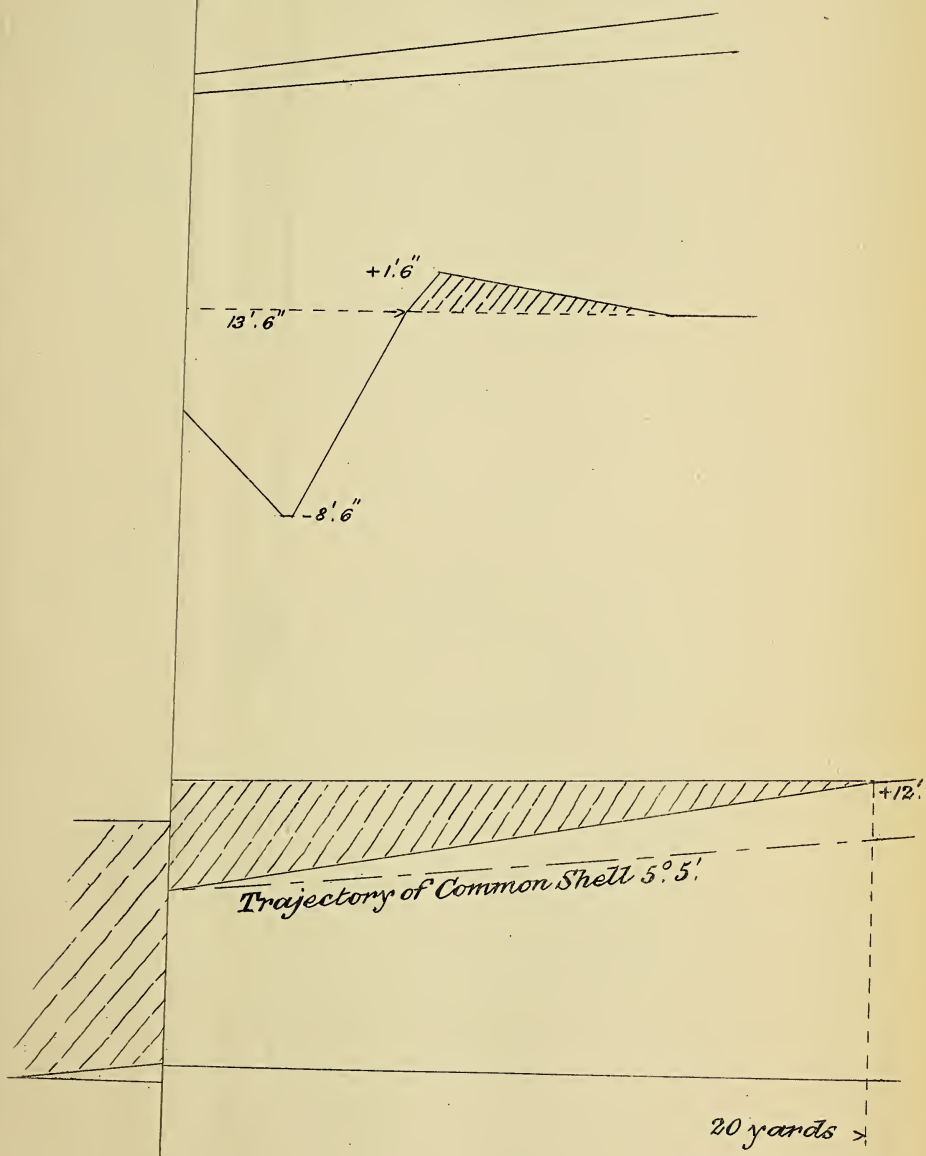
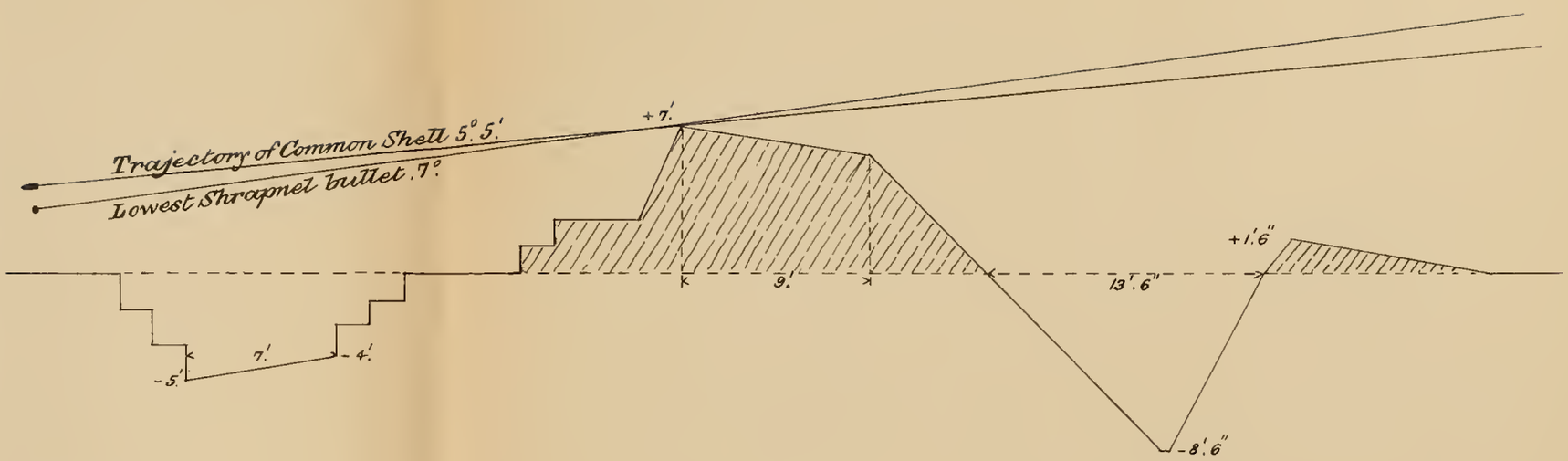
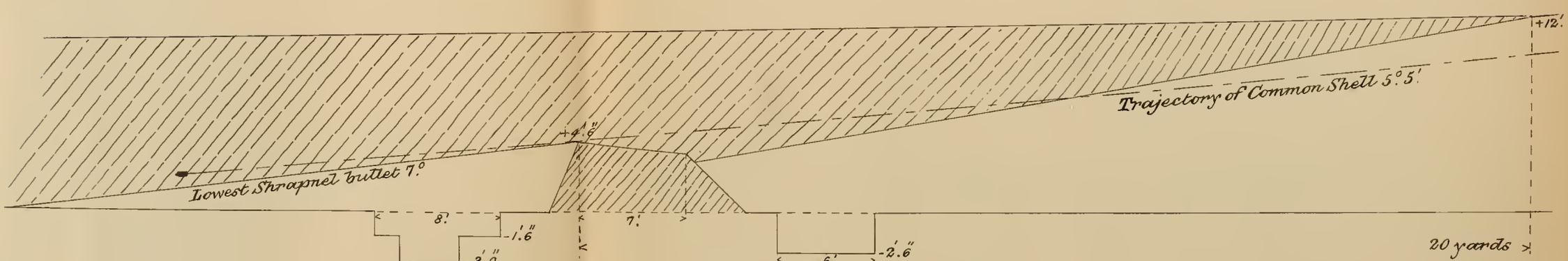


FIG 7.



Scale $\frac{1}{8}$" = 1'.

FIG 8.



artillery, which, as a whole at least, is not likely to be placed in reserve and used as reserve proper, to which alone the term is applicable. Similarly, the term "massing" guns is applied to concentration of guns, and may or may not be intended to include concentration of fire—sometimes it is even applied to the latter without including the former; it would be better, we think, though its object is usually, more or less, concentration of fire, to restrict it to the simple meaning of the word—concentration of guns—leaving such further explanation as the occasion might require to be added.

SHEFFIELD,
March, 1880.

ANNUAL REPORT

AND

ABSTRACT OF PROCEEDINGS OF A GENERAL MEETING OF THE ROYAL ARTILLERY INSTITUTION, HELD ON JUNE 2, 1880.

COLONEL TUPPER, R.H.A., IN THE CHAIR.

1. THE Committee beg to submit the Annual Report of the Royal Artillery Institution to the General Meeting of Members.

2. There are now 1565 Members of the Institution (*vide* Appendix, Table C). During the past year 61 officers have joined the Institution, whilst the deaths and withdrawals have amounted to 51, showing an increase of 10 in the year.

The number of deaths which have occurred in the year has been unusually large. Amongst them are to be noted those of Generals Sir F. Warde, Sir W. Ingilby, Moore, and Huyshe; Colonel Bruce (formerly Secretary of the Institution), Major Ward-Ashton (a Member of the Committee), Captain Shafto, Lieuts. Nicholson, Montanaro, Hardy, and Wright, killed in action.

3. The financial condition of the Institution is very satisfactory (*vide* Table B); the general credit amounting to £2998.

4. The French and German Classes held in the Institution have been well attended. The Landscape Drawing Class has retained its popularity. Classes assisted by Institution funds have also been held at five out-stations for the study of French, Spanish, Italian, Russian, and Landscape Drawing.

5. The Committee have recently undertaken the supply of foreign military periodicals to Members willing to furnish regularly, for publication with the "Proceedings," précis of their contents, as well as translations in full of important articles.

The applications for the magazines under these conditions have been numerous, and the Committee trust that the publication of much valuable professional information hitherto comparatively inaccessible, will be the result of this experiment.

6. The Committee propose to supply gratuitously Maps of Theatres of War, or of other localities of peculiar interest, to all Royal Artillery messes at home and abroad. A map of Afghanistan has already been distributed in this manner.

7. A Tactical Model, after the plan of Major Wilkinson Shaw, has been erected in the Institution, which the Committee trust will be useful to officers desirous of studying Minor Tactics. The thanks of the Members are due to Major Wilkinson Shaw and to Colonel Haldane, for their very careful superintendence of its construction.

8. The subject selected for the Prize Essay of the year was "The Attack of Entrenchments by Field Artillery."

Seven Essays were submitted for competition.

Colonel Smyth, Lt.-Col. Maitland, and Major Nicholson have been good enough to undertake the office of Referees.

The following Report by the Referees was read to the Meeting :—

HORSE GUARDS,
Whitehall, 1. 6. 80.

SIR,

We, the Referees, beg to make the following award in the Prize Medal competition.

The Gold Medal to the Essay "Ex animo operemur et summâ potestate utamur."

We make no award of the Silver Medal.

We wish it to be understood that the award of the Gold Medal is made on the general merits of the Essay, and does not imply that the Referees agree with all the particular arguments put forward therein.

We recommend a revisal of the Rules, with a view of giving the Referees greater latitude in making their award. For instance, a case might arise where the best Essay did not appear quite worthy of the distinction of the Gold Medal, but would be fairly entitled to that of the Silver Medal.

The question of withholding both medals might also be taken into consideration at the same time.

We have the honor to be,

Sir,

Your obedient Servants,

H. A. SMYTH, Col. R.A.,
E. MAITLAND, Lt.-Col. R.A.,
STUART NICHOLSON, Major R.H.A.

The Secretary,
R.A. Institution.

On opening the sealed envelope bearing the motto "Ex animo operemur, &c., &c.," Major William Kemmis was found to be the author.

9. In accordance with the resolution of the last General Meeting, the papers connected with the history of the Regiment presented to the Institution by Lt.-Col. Cleeveland, R.A., have been put into the hands of the printers, and the Committee trust that they will be published in the course of the current year.

10. The accounts of the Institution have been audited this year by Majors Wethered and Higginson.

11. The Committee recommend the following addition to the Rules governing the award of the Gold Medal to the Prize Essay :—

No. 7.—"No Medal will be awarded when, in the opinion of the Judges, none of the Essays submitted are of sufficient merit to justify the award."

12. The following changes in the Committee have taken place during the year :—

Captain S. C. Pratt	... vice	Captain E. Clayton.
" K. Stephenson	" "	A. G. Yeatman-Biggs.
Lieut. F. W. Radcliff	" "	J. S. Clarke.
Lt.-Col. E. Maitland	"	Colonel T. M. Harris.
" W. L. Yonge	" "	W. G. Andrewes.
Lieut. J. R. J. Jocelyn	"	Lieut. P. C. E. Newbigging.

The Committee for the current year will be as follows:—

PATRON AND PRESIDENT:

Field-Marshal H.R.H. the DUKE OF CAMBRIDGE, K.G.

VICE-PRESIDENTS:

The Inspector-General of Artillery.
The Director of Artillery and Stores.
The Deputy-Adjutant-General, R.A.
The Senior Artillery Officer doing duty at Woolwich.

MEMBERS:

The Assistant-Adjutant-General, R.A.
The Director of Artillery Studies.
The Assistant-Adjutant-General, Woolwich.
The Secretary, Department of Director of Artillery and Stores.
Lieut.-General W. J. Smythe, F.R.S.
" Sir J. H. Lefroy, C.B., K.C.M.G., F.R.S.

Colonel H. T. FitzHugh.
" R. Oldfield.
" W. N. Waller.
Lieut.-Col. W. L. Yonge.
" E. Maitland.
" Hon. A. Stewart.
Major J. E. Blackwell.
" W. G. Brancker.
Major H. S. Clarke.
Captain C. Jones.
" C. W. Long.
" S. C. Pratt.
" K. Stephenson.
" F. Roberts.
Lieut. J. R. J. Jocelyn.

Lt.-Col. M. Le Fer Taylor, *Secretary and Treasurer.*

The Annual Report having been read to the Meeting, it was proposed and carried,

"That the Annual Report, as read, be adopted."

The following recommendation of the Committee was carried by the Meeting:—

"By Rule 19, a share not exceeding two-thirds of total expense of all voluntary Classes approved by the Committee, and consisting of at least three Members, may be borne by the Institution.

"The Committee recommend that they be authorised at their discretion to assist from the funds of the Institution any Member who may be desirous of obtaining professional instruction."

The following addition to the Rules regulating the award of the Annual Gold Medal was recommended by the Committee, and carried by the Meeting:—

7. "No Medal will be awarded when, in the opinion of the Judges, none of the Essays submitted are of sufficient merit to justify the award."

Lt.-Col. Hon. A. Stewart and Capt. Long were elected Members of the Committee vice Colonel Whinyates and Lieut. Radcliffe, who have left the station. Major Clarke was elected a Member of the Committee, vice Major Duncan, whose period of service on the Committee had expired. Colonel Waller and Capt. Jones were re-elected.

APPENDIX.

A.

GENERAL ABSTRACT

OF THE

INCOME AND EXPENDITURE OF THE ROYAL ARTILLERY INSTITUTION,

From 1st April, 1879, to 31st March, 1880.

EXPENDITURE.

		£	s.	d.	£	s.	d.
Printing	Wages	138	7	7			
	Paper and Materials	340	8	2			
	Type and Furniture	17	7	7	552	7	0
	Wood Engraving	36	10	0			
	Lithography	19	13	2			
Photography					0	3	3
Classes					149	9	10
Taxidermy					24	2	6
Lectures					31	4	0
Library, and Books for Sale					345	9	4½
Museum					33	0	0
Instruments					20	2	0
Carpentry	Wages	30	12	8	162	6	5
	Materials	131	13	9			
Furniture and Repairs					42	9	1
Subscriptions to Societies			4	4	0		
" refunded			1	5	0	5	9	0
Stationery					103	0	8½
Postage and Parcels					70	6	0½
Incidental Expenses					56	1	10½
Wages to Clerks and Orderlies					156	17	9
W.O. Photographs and Lithographs					12	9	0
Gold and Silver Prize Medals					13	6	0
Fire Insurance					12	10	0
Cash in hand, 31st March, 1880	Of Secretary	2	3	2½	632	0	0½
	Of Messrs. Cox & Co...	629	16	10			
					£2429	0	4½

INCOME.

		£	s.	d.	£	s.	d.
Cash in hand, 31st March, 1879					411	18	4
Printing					89	14	7
Photography					1	4	0
Classes					54	10	3
Taxidermy					18	17	6
Books sold					228	9	6½
Carpentry					60	18	7
Subscriptions	Entrance	59	0	0	1342	2	0
	1872-3	0	16	0			
	1873-4	1	0	0			
	1874-5	1	0	0			
	1875-6	3	2	0			
	1876-7	10	7	0			
	1877-8	22	3	0			
	1878-9	34	15	0			
	1879-80	1198	11	6			
	1880-1	11	8	0			
Stationery sold					103	8	5½
Postage and Parcels					46	5	10½
W.O. Photographs and Lithographs					12	15	9
Dividends on £2000 Consols					58	15	0
					£2429	0	4½

B.

Dr. DEBTOR AND CREDITOR ACCOUNT FOR THE YEAR ENDING 31st MARCH, 1880. Cr.

	£	s.	d.
Printing and Wood Engraving	2	14	7
Books and Periodicals	75	15	7
Carpentry and Picture Framing	6	19	2½
Stationery	0	4	0
Postage and Parcels	6	1	4
General Credit, 31st March, 1880	2998	12	9
	£3090	7	5½

		£	s.	d.	£	s.	d.
Cash in hand, 31st March, 1880					632	0	0½
£2000 Consols Stock, at 98					1960	0	0
Value of Stock.	Printing Paper	42	8	11	112	0	3
	Books for Sale	21	9	9			
	Stationery for Sale	14	17	7			
	"Kane's Lists" (unbound)	13	4	0			
	Chemicals in Laboratory	20	0	0			
Owing by Members.	Printing	9	3	2	380	7	2
	Photography	1	9	0			
	Classes	5	16	0			
	Taxidermy	10	5	0			
	Books and Binding	102	10	11			
	Carpentry	13	6	5			
	Subscriptions	181	3	2			
	Stationery	23	2	9			
	Postage and Parcels	35	1	6			
	W.O. Lithographs	4	9	3			
					£3090	7	5½

Examined and found correct,

E. R. WETHERED, Major and Staff Paymr.

T. C. HIGGINSON, Major and Staff Paymr.

WOOLWICH, May 20, 1880.

C.

Statement showing Increase and Decrease of Members of the R.A. Institution during the year ending 31st March, 1880.

Ranks.	31st March, 1879.	Increase.			Total increase.	Decrease.				Total decrease.	31st March, 1880.
		Promotions.	Retirement.	New members.		Promotions.	Retirement.	Withdrawal.	Death.		
EFFECTIVE LIST.											
Generals and Regimental Field Officers	499	49	—	—	49	—	5	6	14	25	523
Captains	363	62	—	2	64	49	3	3	5	60	367
Lieutenants	482	—	—	57	57	62	—	8	7	77	462
Paymasters	6	—	—	—	—	—	—	—	—	—	6
Quarter-Masters	5	—	—	—	—	—	—	—	—	—	5
Riding-Masters	3	—	—	—	—	—	—	—	—	—	3
Surgeons-Major	1	—	—	—	—	—	—	—	—	—	1
Veterinary Surgeons	4	—	—	—	—	—	—	1	—	1	3
RETIRED LIST.											
Generals and Regimental Field Officers	91	—	5	—	5	—	—	2	1	3	93
Captains	40	—	3	—	3	—	—	—	—	—	43
Lieutenants	11	—	—	—	—	—	—	—	—	—	11
Surgeons-Major	3	—	—	—	—	—	—	—	—	—	3
Surgeons	1	—	—	—	—	—	—	—	—	—	1
Chaplains	1	—	—	—	—	—	—	—	—	—	1
HONORARY MEMBERS.	45	—	—	2	2	—	—	4	—	4	43
Totals ...	1555	111	8	61	180	111	8	24	27	170	1565

D.

Presentations to the Library, &c.

Astronomical and Meteorological Observations for the year 1875	Rear-Admi. John Rogers, U.S.N.
Appendix to United Service Institution of India, Vol. VII.	The Council.
Journal of the United Service Institution of India, Nos. 35, 36, 37, 38, 39, 40, and 41	The Council.
Charter, Bye-Laws, Regulations, &c., of the Institution of Civil Engineers	The Council.
Proceedings of Institution of Civil Engineers, Vols. LV., LVII., LVIII.	The Council.
List of Members of the Institution of Civil Engineers	The Council.

A Panorama in the Deccan, by H.L.C.	The Author.
Handbook for Field Service, 1st Edition	General Sir J. H. Lefroy, R.A.
Annual Report of Instruction at School of Musketry, Hythe, for the year ending 31st March, 1878	D.-A.-A.-Gen. of Musketry.
Remarks upon the Explosion of the 38-ton Gun	Sir W. Palliser.
Rouse's Practical Geometry	Deputy-Adjt.-General R.A.
Treatise on Construction of Ordnance	The Director of Artillery.
Report on Experiment with Krupp Guns	
The Great Russian Invasion of India	Anonyma.
Autotype fac similes from Drawings by Captain S. P. Oliver, late R.A.	The Artist.
Landing of British Troops, &c., on the Beach at Larnaka, Cyprus	
General View of Larnaka, from the Anchorage of the British Fleet, in July, 1878	
Work and Pay, by Leone Levi	S. Morley, Esq., M.P.
Journal of Royal United Service Institution, Parts 101 and 102, Vol. XXIII.	The Council.
Netherlands Artillery Atlas, Plates Nos. 39 to 44, and 118 to 123	Netherlands Government.
Drawing of Block Trail, by Albert Borghardt, January, 1690	A. G. Greenhill, Esq., M.A.
Examination Papers R.M. Academy, Woolwich, 1879	Sir J. Adye, K.C.B.
Do. do. February, 1880	
On Coast Fortification and the Naval Attack of Fortresses, by Major A. Parnell, R.E.	The Author.
Pamphlet on the Calculation of the Trajectories of Shot	W. D. Niven, Esq., M.A., F.R.S.
Report on Experiments made with the Bashforth Chronograph, 1878–9, Part 2	
MS. Table of Distances in Hindustan, dated 1791, by Capt. C. Gold, R.A.	Mrs. C. Moresby, *nee* Gold.
Drawing of 14-in. Brass Spanish Double Reinforced Mortar, first cast by the French at Seville, 1811, to Bombard Cadiz	
Drawing of Brass Spanish 9-in. Howitzer-Mortar, first cast by the French at Seville, to Bombard Cadiz	
Description of all the Seats of Wars in Europe, 1707	Major C. B. Piers.
Reveries of Memoirs of Marshal Count Saxe, 1776	
Report of Final Examination at Staff College, December 1879	Director-Gen. of Military Education.
Eastern Cities and Italian Towns	P. P. Pullan, Esq., F.R.I.B.A.
Elementary Lectures on Christian Architecture	
Canadian Militia Field Artillery Manual, 1878	Colonel T. B. Strange, R.A.
A Plea for the Militia	
Prize Essay, 1878	
Observations on the Armed Strength of Canada	
Annual Report, Dominion Inspector of Artillery	
Report on State of the Militia of Canada for year 1879	

Map of Natal and Zululand	R.E. Institute.
Proceedings of R.E. Institute, Vol. III., Nos. 8 and 9	
Reconnaissance Sketch of Cabul and its Environs, made in 1842 by Capt. Abbott	
Map of Sekukuni's Country, by A. Merensky, 1879	
Proceedings of Zoological Society of London, 1878	The Council of the Society.
List of the Animals of Zoological Society	
Map of Afghanistan, 8 miles to 1 inch, 21 half sheets	Secretary of State for War.
Military Map of Zululand	
The Anglo-Afghan War, 2nd Section, 21st Dec. 1878 to 31st Jan. 1879	
War Office Photographs, Nos. 5499 to 5502 and 5505	
War Office Lithographs, 11 plates	
Report on the Final Examination of the Staff College in December, 1878	
Précis on Zulu Country	
Précis on Natal	
South African Travellers' Handbook	
Eye Sketch of Road between Kasim Khel and Kabul, *viâ* the Shutargardan Pass, with description of Char Asiab	
Reconnaissance Sketch of Kabul and its Environs, made in 1842, by Captain F. Abbot, Bengal Engineers	
Route's compiled by Col. Maeff, on the occasion of his 2nd Journey in Southern Bokhara in 1878	
Map of the Country round Cabul; scale 1 inch to a mile	
Panorama of Cabul from Camp Sia Sung	
Observations by Governors of R.M. Academy and R.M. College on the Remarks of General Sir James Fitzmayer	
Statistics and Geography of Russian Turkestan, by Bt.-Major F. C. H. Clarke, R.A.	
Anglo-Afghan War, 3rd Section	
Geology of the Island of Cyprus	
Memo. on Afghanistan	
Country around Kabul and Ghazni, with the routes leading to India, 1879	
Routes from Quetta and Khalat-i-Ghilzai to Ghazni, 1879	
Map of the Country around Cabul, August 1839	
Plan of the City of Kabool and its Environs, September 1839	
Plan and Survey of the Bala Hissar, or Fort of Cabul, December 1839	
Plan and Sections of Ghuznee, 1840	
Plan of the Country around Kandahar, May 1839	
Plan of Herat Fort, June 1842	

Report of an Explosion of Gunpowder in a Factory at Dartford, 11th March, 1879	Secretary of State for Home Department.
Third Annual Report of H.M. Inspector of Explosives, 1878	
Report of Explosion in Detonator Factory of the Cotton Powder Company at Uplee's Marshes, near Faversham, 16th May, 1879.....	
Report on Explosion of Gunpowder in Doncaster, 3rd January, 1880	
Report of an Explosion of a Glazing House, Faversham, 21st February, 1879	
Report on an Accident in the Detonator Factory of Nobel's Explosives Company at Redding, West Quarter, near Falkirk, 12th May, 1879	
Report on Explosion of Gunpowder at Pentre, Broughton, near Wrexham, 30th Oct., 1879	
Report on an Accident in the use of Dynamite in a Tunnel in course of Construction under River Severn, 23rd September, 1879	
Report on an Explosion in Detonator Factory of Nobel's Explosives Company at Redding, West Quarter, Near Falkirk, 13th October, 1879...	
Russian Artillery Journal, Nos. 4 to 12, 1879, and 1 to 3 of 1880	Russian Government.
Russian Military Journal, Nos. 3 and 4 of 1878	
Russian Small-Arms Journal, No. 4, 1878, and No. 1, 1879	
Greenwich Magnetical and Meteorological Observations, 1876	Astronomer Royal.
Reduction of Greenwich Meteorological Observations	
Report of Astronomer Royal to Board of Visitors, Royal Observatory, Greenwich.....	
Proceedings of the Institution of Mechanical Engineers	The Council.
St. Mark's Rest, by J. Ruskin, LL.D.....	The Author.
Deucalion, Part 6, by J. Ruskin, LL.D.	
Ratnik, Vol. I., and Part 1 of Vol. II.....	Serbian Government.
Proceedings of Royal Geographical Society	The Council.
The Archæological Journal, Vols. VI. to XXI. inclusive, and Nos. 141, 142, 143, and 144...	The Society.
Reports on part taken by Artillery in the various Actions during the late Campaign in Afghanistan	Colonel A. H. Murray, R.A.
Report on Organisation, &c., of Siege Train formed for Service in Afghanistan.....	
Report on the part taken by the Artillery in the various Actions, &c., in Afghanistan, since Military Operations were resumed in October, 1879	
Further Reports on part taken by the Artillery of Naga Field Force	
Return of the Ordnance captured at Kabul in October 1879	

Birds of Colorado Valley. E. Coues .....
Material for a Bibliography of N.A. Mammals
The New Rocky Mountain Tourist .....
Catalogue of Photographs of U.S. Geological Survey .....
Bulletin of the U.S. National Museum, Nos. 1, 2, 3, 7, and 9 .....
Catalogue of Publications of U.S. Geological Survey .....
Origin and Progress of the U.S. Geological Survey
Report of Field Work of the " "
Report of the Comptroller of the Currency .....
Annual Report of the Secretary of the Interior for 1873–4 .....
Bulletin of U.S. Entomological Commission, Nos. 1 and 2.. .....
Catalogue of Minerals found in Colorado .....
Erupted Rocks of Colorado, by F. M. Endlich ..
Arable and Pasture Lands of Colorado.....
Reports of Governors of Territories of Arizona, Dakota, &c. .....
Mineral Wealth, Climate, and Rainfall of Black Hills of Dakota.....
Palæontology of Black Hills.....
On Methods of Surveying the Public Domain ...
Bibliography of N.A. Invertebrate Palæontology
Lists of Elevations West of Mississipi River ...
History of the American Bison..... } Dr. F.V. Hayden, U.S. Geologist.
Report on Rocky Mountain Locust .....
Review of Fossil Flora.....
New Species of Fossil Plants of Lignitic Formation
The Flora of South Western Australia ....
Geology of North Eastern New Mexico .....
Tincina and Entomostraca of Colorado .....
The Twana Indians .....
Researches in Kjokemmnoddings .....
Geology of the Region of the Judith River .....
Methods of Making Stone Weapons.....
Notes of American Insectivorous Mammals .....
Butterflies of Southern Utah and Northern Arizona .....
Tinenia of United States and Canada .....
Studies of American Herodiones .....
Ornithology of Lower Rio Grande .....
Fishes from Certaceous and Tertiary Deposits...
Noctudiæ from California.....
Herpetology of Dakota and Montana .....
Mammals of Fort Sisseton, Dakota .....
Fishes of Fresh Waters of North America .....
Collections of Insects .....
Geological Distribution of Mammalia .....
Description of Fossil Passerine Bird.....
" New Extinct Vertebrata.....
Insects of Tertiary Rocks of Colorado .....

Coleoptera of Alpine Regions of Rocky Mountains	Dr. F. V. Hayden, U.S. Geologist.
Studies on N.A. Pyralidæ	
Palæontological Papers	
Dark Shale, discovered below Devonian Limestone	
Mineralogy of Nevada	
Field Notes on Birds, &c.	
Products of Erosion in Colorado	
Fossil Insects of Green River Shales	
Remarks on Laramie Group	
American Sciuri, or Arboreal Squirrels	
Phænogamous and Vascular Cryptogamous Plants	
Collection of Fishes in Dakota and Montana	
Notes on the Aphidiæ of the United States	
Report of Fossil Flora	
3 Geological Survey Maps	
Tablas Para La Resolucion De Problemas Balisticos	Officers, Academy of Artillery, Segovia.
Tratado De Calculo De Probabilidades	
Diccionario Tecnologico Ingles-Espanol	
Tratado De Balistica and Atlas	
Smithsonian Miscellaneous Collections, Vols. XIII., XIV., and XV.	The Council.
Smithsonian Report, 1877	

Books, &c., purchased.

British Entomology. 16 vols. in 8. Curtis.
The Ibis. Vol. III. Nos. 10, 11, 12.
The Birds of Europe. Parts 73 to 76.
The Elements of Modern Tactics.
8 Photographic Views of the Island of Malta, taken by the late Lt.-Col. C. E. Burt.
Treatise on Natural Philosophy. Thomson and Tait.
Palæontographical Society Papers. Vol. XXXIII.
Jahresberichte. 1878.
Standing Orders, Woolwich District, 1879.
The Birds of New Guinea. Parts 6 to 10.
The Birds of Asia. Part 31.
Application of Physical Forces, by A. Guillemin, edited by Lockyer.
Military Handbooks, edited by Lt.-Col. G. B. Brackenbury. Military Sketching and Reconnaissance.
A Monograph of the Hornbills. Part 6.
Regulations for Engineer Department.
Tactique, par Guichard. 3 vols.
Guerre d'Orient en 1876–7. 3 vols.
Cours d'Art Militaire.
The Birds of Ceylon. Part 2.
Euclid and his Modern Rivals.
Die Preussische Reiterei von 1806 bis 1876.
Contes Fantastiques, par E. Chatrain. 6 copies. (For the use of the French Class.)
Encyclopædia Brittanica. Vol. X.
Handbuch fur unter Offiziere der K.K. Festungs Artillerie, von Semrad and Sterbenz. 1 vol., 1879.

Resurrection of our Lord } Arundel Society.
Madonna and Child }
Herat, the Granary and Garden of Central Asia. Col. G. B. Malleson, C.S.I.
Torpedoes and Torpedo Warfare, by C. W. Sleeman.
Nouvelle Geographie Universelle la Terre et les Hommes, par Elise Reclus.
Carnet de Poche à l'usage des Officiers d'Artillerie, par H. Plessix.
Clery's Minor Tactics.
Boughey's Elements of Military Administration and Military Law. 4th Edition. 1879.
Essai de Mecanique Chimique fondee sur la Thermochimie, par M. Berthelot. 2 vols. 1879.
The Russian Army and its Campaigns in Turkey in 1877–8, by F. V. Greene, U.S. 1 vol. and atlas, 1879.
The Elements of Modern Tactics, by Major Wilkinson Shaw.
Memorials of F. M. Eardley-Wilmot, Major-General R.A.
Biologia Centrali Americana, or Contributions to the Knowledge of the Fauna and Flora of Mexico and Central America.
Zoology. Part 1.
Botany. Part 1.
Official Map of France. Sheets.
1 Box of Men for Krieg-spiel.
1 Set of Maps mounted for do.
Horse Shoes and Horse Shoeing, by G. Fleming, 1869.
Nautical Almanack for 1880.
Manuel de Fortification de Campagne, par Lieut.-General Brialmont.
Post Office London Directory, 1880.
Theory of Heat, Maxwell. 5th Edition.
Units and Physical Constants.
Mathematical Papers of the late George Green.
Further Correspondence respecting Affairs in Central Asia. No. 1. 1880.
Correspondence respecting Affairs in Afghanistan. Vol. I. 1880.
Treatise on the Motion of Fluids, by H. Lamb.
Kriegsfeuerwerkerei Erster Theil mit Atlas.
Do Zweiter do do
Text-Book of Fortification and Military Engineering, for use at R.M. Academy, Woolwich. Part 2.
The Principles of Graphic Statics, by G. S. Clarke.
Peerage, Baronetage, and Knightage of the British Empire for 1880, by J. Foster.
Fremdwörterbuch, von F. W. Loof. 1 vol. 1878.
On the Motion of a Solid in a Fluid, by T. Craig, Ph.D.
Stieler's Hand Atlas. Parts 1 to 13.

E.

Presentations to Museum.

12 Birds from Peru	Mr. H. Whitely, Jun.
An Indian Silver Coin	Major H. M. Burgess, R.A.
Bottle of Locusts' Eggs, from Cyprus	Colonel R. Biddulph, R.A.
Mandarin Ducks (Male and Female)	Mr. H. Whitely, Sen.

F.

List of Papers published in the "Proceedings" during the Year.

Notes on the Organisation and Employment of Siege Artillery. By Captain R. Walkey, R.A., Instructor of Artillery, R.M.A.

The Casting of the 100-ton Gun in the Turin Gun Foundry. (Translated from the "Italia Militare.") Contributed by Lieut.-General H.H. Maxwell, C.B., R.A.

Principles of Gunnery, Rifled Ordnance, by Major J. Sladen, R.A., Professor of Artillery, R.M. Academy, Woolwich. Chapter IX.

An Account by Mr. J. Greaves of some Experiments for Trying the Force of Great Guns. Communicated by Major Tracey, R.A.

The War between Russia and Turkey in Asia Minor, 1877. Translated from "Löbell's Jahresberichte," by Lieut. J. M. Grierson, R.A. Part II.

Extract from a Letter, dated 23rd January, 1879, from Lieut. F. Nicolson, R.A., attached to Major Tremlett's Battery, with the Force under Colonel E. Wood, V.C., C.B., in Zululand.

Notes on the Office Work of a Garrison Battery of Royal Artillery, by Major R. W. Phipps, R.A.

On the Question whether any Development of the Matériel of Field Artillery is Necessitated by the General Adoption of Entrenchments on the Field of Battle; and if so, on the Direction such Development should take, by Lieut. F. M. Goold-Adams, R.A. (The R.A. Institution Gold Medal Prize Essay, 1879).

Notes on the Organisation and Employment of Siege Artillery, by Captain R. Walkey, R.A., Instructor of Artillery, R.M.A. (Continued from p. 446.)

Annual Report and Abstract of Proceedings of a General Meeting of the Royal Artillery Institution, held on May 26, 1878; Colonel FitzHugh, R.A., in the Chair.

On the Question whether any Development of the Matériel of Field Artillery is Necessitated by the General Adoption of Entrenchments on the Field of Battle; and if so, on the Direction such Development should take, by Captain E. R. Elles, R.A. (The R.A. Institution Silver Medal Prize Essay, 1879.)

On the Rotation required for the Stability of an Elongated Projectile, by A. G. Greenhill, M.A., Professor of Mathematics to the Advanced Class of Artillery Officers.

Reports on Mounting of Heavy Ordnance at Malta.

Shooting Properties of the Small-Arms in use in Europe. (Illustrated by Tables from the "Ballistik der Handfeuerwaffen in Tabellen.") By Lieut. A. Indra, Austrian Artillery. Translated by Bt.-Major T. Fraser, R.E.

A Telescopic Sight for Field Guns, by Lieut. D. F. Downing, R.A.

The Austrian Mountain Artillery in the Campaign in Bosnia, 1878, by Lieut. J. M. Grierson, R.A.

Mountain Guns for Indian Frontier Service, by Captain E. Walsh, R.A.

The Weldon Range-Finder, by Major J. B. Richardson, R.A.

JOURNAL OF THE MARCH

OF

5/11 HEAVY FIELD, OR ELEPHANT, BATTERY

FROM MORAR TO KANDAHAR.

BY

MAJOR C. COLLINGWOOD, R.A.

On the morning of 24th September, 1878, without previous warning, telegraphic orders were received from Simla for 5/11, R.A., to proceed without delay on active service. Early next morning (25th) the battery marched out of Morar fully equipped for active service, *en route* for Dholpūr (two marches distant) where it took train for Mooltan. Strength of battery as per margin. Notwithstanding that experiments on an extensive scale had been made by order of government at the camp of exercise at Delhi, nearly three years before, as to embarking, disembarking, and conveyance by train of the several branches of the service, and that this particular battery had gone through exhaustive details in the mode of transit, yet when this occasion arose neither suitable trucks, for the conveyance of guns and ammunition wagons, nor any of the requisites which should have been provided, were forthcoming.

Strength of battery.
3-40-pr. guns B.L.R
3-8 in. mortars.
24 ammunition wagons.
1 spare gun carriage.
1 spare mortar do.
3 store carts.
95 Europeans (including officers), 220 Natives (including artificers), 300 bullocks, 9 elephants, 18 horses. Also (from Sukkur) about 280 camels for baggage and commissariat supplies.

The amount of labor expended in the embarking and disembarking a battery of 35 carriages, including the 40-pr. guns, in trucks whose sides (with few exceptions) would not let down, can be better imagined than described.

The battery disembarked at Mooltan and remained there for five weeks.

Battery at Mooltan.

As it is not yet considered safe, in India, to transport elephants by train, those of 5/11 had to march by road from Morar to Mooltan, and again from thence to Jacobabad, a distance altogether of about 900 miles, before they overtook the battery.

Elephants had to march by road.

The troops under General Stewart were delayed some weeks in Mooltan, owing to the Indus having overflowed its banks; when at last the waters had sufficiently abated, and the ground considered dry enough, the troops were rapidly moved down to Sukkur (the end of the railway at the time). The battery left Mooltan in three trains, each consisting of 35 carriages of sorts, on 10th and 11th November; and here again, as at Dholpūr, the same excessive labor had to be gone through, for want of suitable trucks. The battery was again detained for six days at Sukkur.

Battery in 3 trains.

Sukkur.

On 19th November it started towards Jacobabad; the march (50 miles) being accomplished without the elephants, the road being good, except in a few places where it had been washed away by the floods.

Jacobabad.

Elephants overtook battery.

At Jacobabad a further delay of nine days took place, during which time the elephants came in. At length, on 2nd December, the battery marched *en route* for Quetta, with 30 days commissariat supplies for Europeans, and 14 for natives. The route selected was that over the Kutchi Plain or Desert, by Janghi Khan, Shapūr, and Mittri, to Dadur; thence by the Bolan Pass to Quetta: the number of marches as follows, 8 to Dadur, 6 through the Bolan Pass, and 2 into Quetta.

List of marches;—

Sukkur to	miles.
Mangrani	14
Shikarpur	12
Hermaion	13
Jacobabad	12
Janghi Khan	7
Digri	10
Shapur	16
Chutta	11
Pulagi	12
Lehri	16
Mittri	31
Dadur	13
Kohan di lani	10
Kirta	11
Bibi Nani	10
Ab-i-gum	12
Sir-i-bolan	13
Dusht-i-Bedaulat, or Durwaza	12
Sir-i-ab	15
Quetta	7
Spangli (3 miles beyond)	11
Dina Karez	10
Segi	10
Gulistan Karez	11
Top of Kwaja Pass	10
Kwaja	12
Lake Lagule	14
Kouchai	13
Shah Passand	16
Saffa Deen	13
Deh Hadji	11
Mundi Hissar	10
Kandahar	10
Total	408

During the first marches the ground was very unsound owing to overflowing of the Indus, and on one occasion the three guns got regularly "bogged;" one so badly that it could only be extricated after considerable difficulty with the aid of a "wheel purchase," a lever under the axle-tree arm, and brush-wood in front of the wheels: the elephants could not be used, as the ground also broke in with them, and they, too, had to be hauled out by ropes passed behind.

As Shapūr was approached, much heavy sand had to be gone through, which necessitated the gunners and escort (one company 2/60 Rifles) having to be put on the drag-ropes. On occasions when dry sandy nullahs had to be crossed it was found necessary to use all the bullocks to convey over a half battery at a time. This caused delay, but the allotted number of bullocks for each mortar and wagon team was insufficient where the ground was exceptionally heavy.

The longest march occurred from Lehri to Mittri, viz., 31 miles from camp to camp. The road which had hitherto skirted the Kutchi Plain, now lay across the upper part of it; and was fortunately good, with the exception of a heavy sandy bed of a river, just before reaching Mittri. This long march was accomplished during the night, with a halt of 3 hours at midnight for feeding and rest: the journey was made in 12 hours, actual marching.

Longest march.

No commissariat establishments.

At the halting places during this, and subsequent portions of

the route, there were hardly any commissariat establishments, and the grain and fodder had to be brought in by the drivers, thereby causing them much extra work.

Dadur. Dadur was reached on 11th December, where orders awaited the battery "to proceed without delay, filling up commissariat supplies for Europeans and natives, and taking 8 days supplies of grain and fodder for *all* animals." The latter part of the order it was impossible to comply with, as this of course implied a very large increase of carriage, and on applying to the commissariat (there was no transport officer then) it appeared there was none whatever, not one camel could be got. No assistance was given by the authorities towards bringing in the supplies of forage, which had to be cut in the fields by the men of the battery themselves, nor was anything provided to contain or carry them; and in the meantime the D.-A.-Q.-M.-General was continually urging the departure of the battery. During the afternoon of the 11th, and whole of the 12th, all the men including the escort, were engaged in cutting fodder and packing it in salleetahs and blankets belonging to the battery, which were then placed on the top of the wagons, spare carriages, and wherever space was found.

No extra carriage to be got.

At the last moment the officer commanding the battery was enabled to obtain, through the kind permission of the agent to the Governor-General, the use of 100 camels, for two marches only; and, after great pressure brought to bear on the commissariat, 24 carts, for one march, were also obtained. Even with this, the battery had to start with little more than half the stipulated amount of supplies, but the officer commanding was assured that forage would be obtainable at one, or more, stations in the Bolan. Thus, the battery left Dadur on the morning of 13th December.

The cruel necessity of having to increase, rather than decrease, the weight of the wagons, &c., previous to making the passage of such a Pass as the Bolan, was greatly to be deplored. (6/11, also a heavy battery, when following a few weeks later, were supplied with 700 extra camels for carrying an ample amount of supplies, as well as the ammunition from out of the wagons, and so got along very well).

Passage of Bolan Pass commenced. At two miles from Dadur the Pass was entered, and for the first 15 miles or so, the road lay along the winding bed of the river—necessitating frequent crossing and re-crossing—very stony, and in many places large boulders; it was surprising how well the carriages stood the terrible jolting. Numbers of dead camels were to be seen *en route*, in all stages of decay, nick-named by the men "scent bottles."

Dead camels *en route*.

Kirta. Shortly before reaching Kirta, the bed of the river was left by a steep ramp, and the road continued over a plain, tolerably good, but very stony.

"Kerbi" a stubble of a certain grain. "Bhoosa" chopped or broken straw.

At Kirta, it was hoped supplies of "kerbi" and "bhoosa" would be obtainable, but the officer commanding could only procure a very small quantity of the former. Here the first hard frost was experienced.

The march to Bibi Nani was continued over what is called the "Kirta Plain," level, but very stony. At Bibi Nani, the bed of the river had again to be taken and followed out through the remainder of the Pass; it consisted of loose and deep shingle, through which water percolated; the ascent was considerable the whole way, here and there steeper than usual.

Mach.

Mach, is a telegraph station about mid-way up the Pass, though not then a halting place. To within a few miles of this place the battery had progressed very well, without the loss of an animal;

Bullocks becoming lame.

but now grave difficulties commenced. The bullocks began to get foot-sore from the loose shingle, probably aggravated in a large measure by getting their feet wet by day, and frosted at

Supplies running short.

night. The forage and grain supplies began to run short; and, contrary to expectation, nothing but a little coarse grass was to be obtained at Mach. On learning this, the officer commanding immediately telegraphed to Quetta that no supplies were obtainable at Mach, and requested that some should be sent to meet the battery.

Sir-i-Bolan.

At Sir-i-bolan, the battery was detained two days, to permit of bringing up the wagons and spare carriages which had got in rear, and to afford rest to the cattle before commencing the last, and most difficult, march in the Pass. All animals were now on

"Otta," coarse flour.

a very reduced scale of fodder rations, while that of the grain and

Supplies running short.

"otta" was increased; and, perceiving that provisions could not possibly hold out much longer, the officer commanding again telegraphed the state of affairs to Quetta, beseeching the authorities to send supplies for the cattle at once, as they were starving. In reply, it was stated, "there was no carriage in Quetta by which to send supplies, that if possible some would be sent to Dusht-i-bedaulat, and in the meanwhile the battery was to push on with all speed."

2/60 Rifles.

On 20th December the battery left Sir-i-bolan, the guns having been sent on the previous evening to Dozan Nullah, (about 5 miles up the Pass), to enable them to get through the Pass before night-fall. Here the road narrowed and became steeper, and the increase of labor to the animals was so great, that on the 2/60 Regt. happily overtaking the battery, their commanding officer, on request, kindly allowed his men to assist at the drag-ropes; but notwithstanding this additional aid, the animals were quite unable to accomplish the march. The elephants and bullocks had become so enfeebled from want of sufficient food, and so foot-sore, that they

Cattle becoming exhausted.

lay down exhausted, and in many instances, never to rise. Only ten carriages succeeded in reaching camp at Durwaza (or Dusht-i-bedaulat) the same day, and then, only just before dark; the

remainder of the carriages had to be left in the Pass, the elephants and bullocks being brought into camp. Since leaving Sir-i-bolan the cattle had suffered much from want of water, as the Pass was now dry. The Pass had proved to be about 70 miles long, and, at the head of it, the road led up a steep ramp to the plain above. Here the elephants were of important use in bringing up the guns, four to each gun.

"Head" of the Bolan Pass.

On reaching Durwaza, much to the surprise and grief of the officer commanding the battery, no grass or fodder of any kind was to be found, with the exception of some "bhoosa"; great endeavours were made to induce the elephants to eat the latter, but with little success. The following entries in the journal were made here :—

Dusht-i-bedaulat, or Durwaza.

21*st December*.—The cold during the past night was severe, thermometer 14° (Fahrenheit) and a keen wind; one elephant died this morning from the extreme cold, and fatigue of yesterday. No water to be obtained for the cattle, as there is only one well here, and another about 2 miles off, the water from both being fully consumed by ourselves and the 2/60 Regt. The water soon runs dry, and it is only by leaving the wells alone for some hours, under a sentry, that it can be again obtained. As it was reported that water was to be found in a side nullah some miles down the Pass, the cattle were sent there.

Severe frost.

Scarcity of water.

22*nd*.—The 60th Regt. went on to Quetta, but the 59th coming up, the officer commanding that regiment was also requisitioned for the use of his men, and with their assistance the remainder of the carriages were brought up the Pass. Another elephant and many bullocks died to day. There was still little or no water to be obtained, for the 59th having taken the place of the 60th, they kept the two wells pretty dry. Hearing there was abundance of water at the stage in front, half the battery was sent on in the forenoon.

59th Regiment.

23*rd*.—By this time, owing to extreme cold, want of food and water, the number of bullocks was fast diminishing. The remaining portion of the battery marched to Sir-i-ab; on the road it was most distressing to see the poor bullocks lying down utterly exhausted, and quite unable to proceed; many had to be abandoned, as it was too cold (even had it been safe) to leave the drivers out during the night. As it was, some followers left in rear by preceding corps, were to be seen frozen to death by the side of the road. The 59th Regt. again rendered good service by assisting at the drag-ropes; but, after all, only the guns, with a few wagons, succeeded in reaching camp before dark. Next morning the bullocks that were able, were sent back and more of the carriages brought in, but it was several days before they all arrived at Sir-i-ab; and it was not until the 28th that the battery reached Quetta.

Number of bullocks dying.

Sir-i-ab.

Here, orders again awaited the battery "to proceed to the front

Quetta.

at once," but now so many bullocks had died, or become disabled, that it was found absolutely necessary to leave in the arsenal at Quetta the 3rd and 4th line of wagons, the spare gun and mortar carriages, and one store cart.

3rd and 4th line of wagons left in arsenal in Quetta.

On the 30th the battery again marched towards the front, with 1st and 2nd line of wagons, 2 store carts, and about 160 of the bullocks best able to march; 50 had to be left in Quetta unfit to proceed. Two fresh elephants had been obtained for the battery, from the commissariat, to replace those which had died. The commissariat establishment of the battery was again replenished, but no fodder for the cattle taken, as it was said this would be found on the road; (but, alas! this proved not to be the case except in a few instances.) General Stewart and most of the troops were still in front, and the General had left express injunctions for the battery to push on with all speed, to be ready in the event of Kandahar offering any resistance. The battery was escorted by the Head-Quarters and a wing of the 3rd Ghoorkas; a company of sappers also formed part of the column.

Ghaziaband Pass.

On the second march from Quetta, the Ghaziaband Pass had to be crossed; this proved about 6 miles long, and towards the summit very steep. The water at each halting place on either side of the Pass was so brackish the animals would scarcely touch it, and consequently suffered much from thirst for 56 hours. Between this and Gulistan Karez a large river was crossed; the banks being steep, ramps had been cut. The water was about 2 ft. deep, so that, except in the case of a few quicksands, no difficulty was experienced in crossing. Since leaving Quetta no fodder for the elephants had been obtainable except a little lucern grass, and not always that; the day after crossing the river another elephant died, and on reaching Gulistan Karez another was so fatigued that a dram of rum was given it, as this plan was found efficacious in cases of extreme exhaustion.

Water, "brackish."

Death of another elephant.

Gulistan Karez.

On the 2nd of January, 1879, Gulistan Karez, at the foot of the Amram Range, was reached, where orders were awaiting for "two day's supplies of all kinds to be taken," as it would take two day's to cross the Pass, and it was notified that nothing whatever was to be got at the top. As there was no commissariat officer at Gulistan, the Officer commanding the battery again experienced great difficulties in getting in these supplies: all the villages for some distance round had to be requisitioned, and as sufficient could not at once be obtained, the battery was of necessity delayed one day. Whilst at Gulistan, the officers and men were warned not to undress, but to lie down with their arms and accoutrements, ready to turn out at a moment's notice, as a night attack was expected, but nothing occurred.

Scarcity of provisions.

False "alarm."

Top of Kwaja Pass.

On the 4th of January the battery again started forward, with orders to proceed *viâ* the Kwaja Pass; (most of the troops went by the Kojak). The camping-ground, about 2 miles short of the

top, was reached with tolerable ease and safety; the road was good, having been made by the sappers and native regiments. We were a good deal troubled by a few of the hill-men hanging about, and attempting to carry off the lame bullocks and camels in rear. These tribes live principally in caves and holes in the ground. During this night rain fell, and, being followed by severe frost, the tents next morning were so frozen, they could not be packed until the sun had been up some little time. The height of the Pass was calculated to be about 7200 ft. above sea-level: towards the top the road became very steep, with several sharp turns. Here the elephants proved most useful, for had a long team of bullocks been used in the guns the greater part of their power would have been lost, and even the lead elephants had to be taken out, the turns being so abrupt and cramped for space. Again, in descending these steep places, the elephant with his breeching had complete control over the gun, and could bring it down in perfect ease and safety. The scenery of the lower part of the Pass was very picturesque, but here, as in all the country we had passed, there is a great lack of trees, merely a few stunted ones here and there.

Hill-men troublesome.

Severe frost.

"Descent" of Kwaja Pass.

After leaving the Amram Range, a plain of some 26 miles was crossed, through heavy sand a great portion of the way (the border of the great Seistan Desert), which again proved very trying to the poor elephants and bullocks; more especially as not a drop of water was to be got, except at a small lake some miles off the road, where we halted for a night. Here, too, forage was so scarce, the men though fatigued with long marches, hauling on the drag-ropes, and not reaching camp till near dark, had to go out and scrape together what little grass could be found.

Sandy plain.

Great scarcity of water.

At Kunchai, again, there was so little water the bullocks could not get any, and had to go without it for 36 hours until they reached Shah Passand. The country was still tolerably level, but intersected with low ranges of hills; the roads very stony. The elephants and bullocks were still suffering terribly from sore feet, and hardly able to travel.

Kunchai.

Shortly before reaching Saffa Deen another elephant became *hors de combat* and was obliged to be left behind.

Death of 4th elephant.

At Deh Hadji we were informed of the engagement our cavalry and advance column had had with the enemy, and the latter had been completely routed. A few miles short of Deh Hadji, one of the guns in passing over a moist part of the road, caused it suddenly to give way, and the gun sank till one wheel almost disappeared, and the ground immediately surrounding quickly became a quaking bog. Being late in the day the gun had to be left in charge of a guard till next morning, when a strong party from the battery, and company of sappers, was sent back to extricate it. This proved a somewhat difficult matter, as in the equipment of a heavy field battery, no gyn, or other means of mounting a gun, is

Scene of engagement with enemy.

Gun "bogged."

included. However, with the aid of some baulks of timber, belonging to the sappers, a sort of derrick was erected, the weight of the gun taken, swung to one side, the carriage then hauled out, and the gun lowered into its place.

Irrigation channels and Argasan River.

The latter marches, before reaching Kandahar, were much intersected by irrigation channels, which caused much inconvenience and delay to a battery of this description. At six or seven miles from Kandahar, the Argasan and Tarnak (large rivers) were crossed without much difficulty.

Kandahar.

Kandahar was reached on the 13th of January, 1879. It was all the elephants and bullocks could do to get in, and it was months before they, in any measure, recovered from their lameness and very low condition. At first, fortunately, fodder in Kandahar was very plentiful, consisting of lucern grass and green barley. Supplies for the native followers were also abundant; and the Bazaars were richly supplied with the far-famed Afghan dried fruits, which were especially acceptable to the troops after existing merely on rations for so many weeks.

Plenty of supplies.

During the long march the health of the battery was very good, only two or three deaths among the natives, and those mostly from exposure.

The conduct of the men throughout was exemplary.

PROFESSIONAL NOTES

EXTRACTED FROM MY DIARY

DURING THE SOUTH AFRICAN WAR OF 1878-9,

BY

LIEUT. F. G. SLADE, R.H.A.

Introduction.

Having been asked by several of my brother officers to publish some of my notes taken during the late campaigns in South Africa, I have great pleasure in contributing the following paper to the "Proceedings of the Royal Artillery Institution."

In it I have only treated of the part actually taken by the guns immediately under my command, and I must therefore ask my readers to pardon me if I appear to them to be too egotistical.

On the 25th April, 1878, having volunteered for active service at the Cape, I embarked in the U.S.S. "German," and after a voyage of 36 days—including stoppages at Madeira, St. Helena, Cape Town, Port Elizabeth, &c.—arrived at the port of East London, on the coast of British Kaffraria, on the 31st May. The surf is so great at the mouth of the river that passengers, cargo, &c., have to be transhipped in baskets to surf boats before a landing can be effected. The following morning I reported myself at King William's town, which was then the base of operations of the troops operating against the Kaffirs in the Perie Bush. Landing in S. Africa.

On the 18th June I was ordered to take over the command of two 7-pr. mountain guns, then stationed at Gozo Heights, on the highest summit of the Buffalo Range, overlooking the bush, and which up to this time had been commanded by Lieut. Giles, R.A. The guns were 7-prs., of 200 lbs., mounted on low carriages, each drawn by three 7-pr. division on low carriages.

mules, placed one in front of the other—tandem fashion. The harness was of the ordinary mule pattern, as used in the colonies, and a Hottentot driver ran alongside the wheel mule holding the reins, while another coloured man led and guided the leading mule. The first man carried a long whip. The detachments, consisting of six Royal Artillerymen, and 13 men of the 2/24th Regiment, marched in the order of march.

This mode of moving the guns has the great advantage of being able to take them through narrow bush paths, where carriages with a wider track could not possibly travel. On the other hand, these low carriages are liable to turn over very easily on rough ground, and in wheeling. In going along bush paths, where the stumps of the felled trees still remain standing, this fault was particularly noticeable, and on one occasion the leading gun of the division fell on its side no less than seven times in marching through a belt of bush not one mile broad. To obviate this as much as possible, two men held on to the handles of the limber boxes, one on each side, so as to keep the small limber on its wheels when it was inclined to turn over.

The spare ammunition to this division was carried in one ox wagon and one Scotch cart, also drawn by bullocks.

Amount of ammunition so carried :—

		No.
Common shell		100
Shrapnel	"	138
Case shot		10
Cartridges (12-oz.)		199
Friction tubes		245
Fuzes	9 secs.	228
	5 "	113
	R.L. percussion	100

In going down steep inclines the detachments had invariably to take the weight in rear by means of drag ropes.

This division was broken up, and the guns, &c., returned into the ordnance store at King William's town, at the conclusion of the Gaika war.

Campaign against Secocœni.

On the 22nd September, 1878, at Fort Weeber, Secocœniland, having marched from Pretoria as staff officer to Major Russell's column, I took over a 6-pr. B.L.R. Armstrong gun, and continued to march with the column. It was drawn by eight mules with pole-draught, and driven by a native who sat on the limber. The detachment, which consisted entirely of men of the 1/13th L.I., marched in the order of march.

6-pr. B.L.R. Armstrong drawn by mules.

I took up another gun of a similar nature, and mounted in the same manner, a few days later on.

Feigned attack to assist the passage of a column over mountain pass.

On the morning of the 24th September, a small force, consisting of one 6-pr. B.L.R. gun, one company 1/13th L.I., and 80 natives—the whole under Major England, 1/13th L.I.—marched from Fort Faugh-a-ballagh to make a feigned attack on Magnet Heights, with a view of drawing the enemy away from the end of the mountains overlooking the pass through which the column had to march.

Advancing rapidly to within 1200 yds. of a large stadt or village, I opened fire upon it, supported on either side by the company of the 1/13th L.I., and the native contingent. As soon as the first shot was fired, the enemy swarmed down the mountains from all directions, blowing their war horns* and shouting.

After firing for half-an-hour at the stadt with very good effect, the gun was retired and sent under escort to rejoin the column, the infantry retiring at the same time slowly towards Fort Faugh-a-ballagh. The men of the 1/13th L.I. had had only one hour's instruction before they were called upon to work the gun under fire, which they did to my entire satisfaction.

This feigned attack proved entirely successful, as the column had crossed the pass in safety before the enemy, who had been drawn away by the sound of firing, could return and hold it.

After joining the main column under Colonel Rowlands, V.C., C.B., at Fort Burgers, I substituted six Zulu oxen for the eight mules, and drove them with pole and the ordinary yoke.

This was done on account of the limited number of mules available, and for the reason that the bullocks were easier to feed, not requiring any forage.

On the 27th September the column was attacked during its passage through the Elephant's Poort, but it being unadvisable to bring the guns into action, the attack was repulsed by the infantry alone.

On the 25th October, a column, composed as follows :—

Royal Artillery (two 7-prs. and two 6-prs.)	53	men.
1/13th L.I.	480	"
Swazies	189	"
Native Contingent	308	"
Mounted Infantry	50	"
Frontier Light Horse	100	"
Raaf's Horse	60	"

under the command of Colonel Rowlands, V.C., C.B., marched from its camp in the Speckboom Valley, to attack Tolyana's stronghold. Bivouac was formed that night at Johanne's Kraal. On the 26th October the column marched through the Elephant's Poort, where it was again attacked, and bivouacked on the Steelport Road. At 3.15 a.m., on the 27th, the column crossed the river in two divisions, and advanced in the grey dawn towards the stronghold, which rose nearly perpendicularly out of the plain. While crossing the river, one of the gun mules of the mountain train, commanded by Lieut. Nicolson, R.A. (afterwards killed at Kambula), slipped down the bank and fell into the water, and was nearly drowned in consequence of the weight of the gun keeping the animal below water.

Assault of Tolyana's stronghold.

Advancing in line to the point of attack, the guns opened fire at 1300 yds., against the stadt of 200 huts, situated at the foot of the mountain, and surrounded by a thick hedge of prickly pear. The shell

* The Secocœni Kaffirs are the only South African tribe who use the war horn.

fire had the desired effect of driving the enemy out of the village, and then the infantry advanced still supported by the fire of the guns, which had in the meantime advanced to 950 yds. range. The assault was made from three points, but the artillery fire only supported the direct attack. After six hour's fighting the heights were crowned, the mountain taken, and the enemy dispersed.

The officer commanding the direct attack reported that during the assault the artillery fire kept down that of the enemy most effectually. As the enemy retired up the mountain before our skirmishers, the fire of the guns was not masked until within a few minutes before the crowning of the heights.

The 7-prs. fired common shell throughout the action, and the 6-prs. segment shell, with percussion fuze, there being no common shell in the country. The absence of common shell was much to be regretted, but it appears that the segment shells, bursting on impact against the rocks, did considerable damage; the segments finding their way so easily between the rocky boulders.

The bullocks worked well through a long day, over rough ground, and at one time trotted for 1½ miles with a cavalry escort.

It appeared in General Orders, published after the action, that the excellent practice made by the guns contributed materially to the success of the day in keeping down the enemy's fire during the advance of the infantry.

The column under Colonel Rowlands, V.C., C.B., ultimately marched to Middleburg, in the Transvaal, where, on the 23rd November, I handed over the 6-pr. Armstrong division to Lieut. Chamberlain, 80th Regt., having previously instructed two detachments of the 80th Regt. in the drill and working of the guns. There being no drag-shoes issued with these guns, the wheels were checked by passing a short piece of picket-rope (kept for the purpose) over the breech, and making fast to two corresponding spokes of the gun wheels. This acted admirably, but over rocky ground it caused a great strain on the elevating screw, spokes of wheels, and axletree-arms.

Substitute for drag-shoes.

On the 23rd December, having arrived at Utrecht, I was attached to Major Tremlett's battery, then forming part of the column under Colonel Evelyn Wood, V.C., C.B. I was given over a division of the battery (11/7), consisting of two 7-pr. M.L.R. guns of 200 lbs., mounted on Kaffrarian carriages, drawn by six horses, harnessed and equipped in the ordinary manner.

7-pr. M.L.R. guns on Kaffrarian carriages.

The carriage of the Kaffrarian pattern is constructed on the same plan as the 9-pr. (Mark II) carriage—the bracket plates being lightened out—and it is fitted with the same tensile stays to the axletree-bed. The wheels are of the 3rd class, 5 ft. in diameter. The elevating gear consists of an arc attached by a bolt to the cascable, and passing through a metal bracket upon the front of the rear transom. The arc is worked by a pinion at the back of the latter, which is cut through to permit it. The pinion has a worm-wheel, with friction cone on its extremity outside the bracket, which is worked by a worm with hand-wheel.

Carriage.

Elevating gear.

The limber is similar to the field limber, but has 3rd class wheels and axles, the same as its own carriage.

Limber.

There were no wagons with this division; the ammunition, tents, kits, rations, forage, spare gear, &c., being carried in one Scotch cart, one American wagon, and one ox wagon.

The ammunition of the division was carried as follows:— Distribution of ammunition.

Shrapnel shell	30	Carried in limber and axletree boxes of each gun.
Common "	24	
Case shot	12	
Friction tubes	100	
5-secs. fuze	20	
9-secs. "	20	
R.L. percussion	16	
Sensitive fuze	5	
Cartridges (12-oz.)	101	
" (4-oz.)	5	

Shrapnel shell	35	Carried in the divisional Scotch cart, packed in their own boxes. Weight: 908 lbs.
Common "	35	
Double "	10	
Rockets	12	
5-secs. fuze	60	
9-secs. "	30	
R.L. percussion	30	
Friction tubes	70	

N.B.—The Scotch cart (drawn by mules) kept as near the guns as possible, and besides the ammunition, carried rocket trough, men's blankets, and waterproof sheets. Two men to work the trough rode on the cart in addition to the driver (a native).

Shrapnel shell	15	Carried in the divisional American wagon. Weight: 480 lbs.
Common "	33	
5-secs. fuze	20	
9-secs. "	82	
R.L. percussion	88	
Cartridges (12-oz.)	49	
Friction tubes	200	

N.B.—The American wagon (drawn by mules) carried in addition 16 blankets, 26 horse blankets, five tents, spare shaft, collarmaker's tools, officer's kit, and valises (at the rate of $\frac{1}{3}$ of a valise to each man). No valises were carried on the horses. The drivers carried a change of linen rolled up in their blankets, which were carried on the off horses, and the detachment carried the same change in the two valises behind the limber. Men's kits. How carried

Shrapnel shell	10	Carried in the divisional ox wagon. Weight: 932 lbs.
Common "	40	
Rockets	48	
Cartridges (12-oz.)	49	
5-secs. fuze	10	
9-secs. "	20	
R.L. percussion	30	

N.B.—The ox wagon was generally with the baggage of the column, and carried besides ammunition, rations, spare gear and materials, farrier's tools, forage, and remainder of men's kits.

Marking of ammunition boxes.

As these carts and wagons were often used in camp for fatigue purposes, the ammunition had to be off-loaded and stacked, and to prevent any mistake arising in re-packing, the following marking of boxes was adopted:—

All belonging to the Scotch cart were marked O; all belonging to American wagon Δ; all belonging to the ox wagon OX.

Small-arms. How carried

After the disaster at Isandhlana, small-arms were issued to the artillery, which were carried as follows in my division:—All Nos. 1 and drivers carried a revolver in case slung over the shoulder. Four M.-H. carbines were strapped to the front of the limber boxes. All men not actually working numbers of the gun carried a M.-H. carbine slung over the shoulder.

Range tables.

As the range tables issued with the 7-pr. gun were found not to hold good in the African climate, a new table was compiled, which, being written on a strip of leather, was sewn on the back of the off axletree box back band. In addition to this, each No. 1 had the range tables, both for ordinary and double shell, written inside his helmet.

Gun spikes.

The gun spikes were removed from the axletree boxes, and carried by the officer in his revolver ammunition pouch. The N.C. officers and men were informed of this.

Position of Nos. 1 over rough ground.

To prevent the lead horses falling into ant bear holes, or coming to grief in other ways, over rough ground, the Nos. 1 of each gun rode 5 yds. in front of their respective sub-divisions.

Declaration of war with the Zulus.

War having been declared against the Zulus, Wood's Column crossed the Blood River on the 6th January, 1879, and encamped on the Zulu bank. My division, then on detachment at Balte's Sprint, did not receive orders to advance until the 10th January, on which day we marched at 4 a.m., arriving on the right bank of the Blood River at 8.15 a.m. The river was very much swollen, and there was no ford. Having received orders to cross as soon as possible, in order to accompany a flying column marching that afternoon in the direction of Rorke's Drift, with the object of covering the crossing of No. 3 Column at that point, I commenced the passage of the river at 10 a.m.

Division of guns crossing a rapid stream.

The horses and mules, being stripped, were driven into the river. They were carried some way down stream by the current, and were secured on the opposite bank by those drivers who had been able to swim across previously. The barrels of a water cart, attached by a running line to each bank, served as a raft, on which was carried all ammunition, limber boxes, harness, rations, kits, and those men who were unable to swim. The guns, limbers, Scotch cart, and American wagon were dragged through the bed of the river by means of the divisional picket line; and at 11.20 a.m. the division marched into Head-Quarter Camp complete. The passage of the river was accomplished in 1 hour and 20 minutes, without a single casualty.

At 2 p.m. the same day, the division accompanied the flying column towards Rorke's Drift, halting at 7 p.m. At 1.30 a.m. the following morning the column continued its march, and after going 10 miles halted, and sent on the cavalry and two guns, under Lieut. Bigge, R.A., 12 miles further on, where they were met by Lord Chelmsford and staff, who had ridden to meet them from Rorke's Drift. The lines of

advance into Zululand being now determined on, the column retraced its steps, and worked its way up into the north of Zululand.

On the 24th January the column under Colonel Wood, VC, C.B., marched from its camp on the Choba at 4 a.m.; two companies 90th L.I., the Frontier Light Horse, and the division under my command forming the advance guard. At 7.30 a.m., while skirting a small hill near the Inhlobane Mountain, the cavalry scouts reported a large body of the enemy in the low ground to the right of our line of advance. The guns were immediately sent off at a rapid pace under escort of the Frontier Light Horse, and came into action on a commanding position against a dense mass of Zulus, estimated at 3000. Action of Tungin Nek, 24th Jan.

The enemy were completely taken by surprise, and did not break their close formation until several shells had fallen in their midst. They advanced towards us, and worked round to our right on to the rocky terraces of the Lower Inhlobane. When first coming into action, at about 2000 yds. (we could not advance nearer on account of a precipice in our immediate front), I fired shrapnel shell with 9-secs. fuze, and I regret to say that the shells invariably burst short. I attribute this either to the fuze composition having become too dry, or to the wood of the fuze shrinking away from the composition. The small effect caused by the shrapnel at this long range convinced me that the 7-pr. shrapnel should not be used at ranges over 1000 yds., on account of the very low initial velocity (968 ft.) This was the only time during the war on which I used the 9-secs. fuze. At closer ranges on the same day, the 5-secs. burnt admirably. After having been in action for half-an-hour, the enemy were beaten off, the infantry and Lieut. Bigge's guns having in the meantime become engaged, and Colonel Wood having heard of the defeat sustained at Isandhlana by No. 3 Column, he ordered the retire.

This was the first occasion on which the natives of Northern Zululand had felt the effect of artillery fire, and from reports received from the natives afterwards, the moral effect seems to have been very great.

The artillery of the flying column was not again engaged until the 29th March, on which day Colonel Wood's camp at Kambula was attacked by 25,000 Zulus, under the command of Mnyamane, the King's Prime Minister. Battle of Kambula.

The account of this battle has already been so often written, that I will refrain from dwelling too much upon it, referring only to the part taken by the artillery.

The two mule guns were in position on low carriages *en barbette* in the redoubt throughout the day, under the command of Lieut. Nicolson, R.A., who fell mortally wounded in the early part of the battle while directing the fire of one of his guns.

The two mounted divisions under Lieut. Bigge and myself, came into action, at the commencement of the engagement, in line at full intervals, under Major (now Lieut.-Col.) Tremlett. The two divisions were afterwards separated, that under Lieut. Bigge taking up its position on the front and right front of the laager, and that under my command holding the right of the laager.

These guns remained outside the entrenchment throughout the day,

but the horses were sent inside on account of their exposed position. Before they were ordered in, which was when the enemy had advanced to within 100 yds. of the guns, my horse had been shot, Lieut. Bigge's and others wounded.

At 1.45 p.m. the first shell was fired at the right horn, which had driven in our cavalry, at a range of 600 yds. The fire of the artillery, aided by the well directed fire of the 90th L.I. succeeded in breaking the right horn, which retired and took refuge in the rocks and uneven ground to the left front of the redoubt. They never re-formed during the engagement.

The main body, or chest of the army, together with the left horn, now came on simultaneously, enveloping our front, right, and right rear.

Against the repeated attacks of these forces, the guns played without ceasing, at ranges varying from 300 to 60 yds. Case shot was much used at close quarters and did considerable execution. Shrapnel shell with fuzes bored short were used as a rule, except when the enemy took shelter in the huts of our native allies, when common shell with percussion fuzes were fired, which effectually drove the enemy out, and thus exposed them to the withering fire of the infantry in the redoubt.

At 5 p.m., the enemy turned, and the cavalry were sent out in pursuit, the guns still firing at increasing ranges. At 7.30 p.m., the cavalry returned, having pursued the enemy for seven miles.

The average number of rounds fired by the guns of Major Tremlett's battery on this day was 80.

On two occasions during the engagement, the guns of my division became so heated that water had to be thrown upon them in order to allow of the vent being served. The effect of the artillery fire on this day was most marked; not only by the number of dead found lying in front of the guns, but by the reports received from natives afterwards, and by the visible effect on the advancing columns, especially at close quarters, when case was being fired.

Effect of the artillery fire.

During an interview with Cetywayo and one of his chiefs, at Cape Town, last April, the latter stated that one round of case shot, fired during the battle of Kambula, killed no less than 10 head men of his own regiment, besides wounding others; and that it was with the greatest difficulty that he could persuade his men to face the guns.

The following is an extract from the despatches published after the battle :—

Extract from Colonel Wood's despatches after the battle of Kambula.

"The two mule guns were admirably worked by Lieut. Nicolson, R.A., in the redoubt, until he was mortally wounded (since dead) when Major Vaughan, R.A., Director of Transport replaced him, and did good service. The horses of the other four guns, under Lieuts. Bigge and Slade, were sent inside the laager, when the Zulus came within 100 yds. of them, but these officers with their men, and Major Tremlett, R.A., to all of whom great credit is due, remained in the open the whole of the engagement."

Battle of Ulundi.

At the battle of Ulundi on the 4th July, the artillery was again brought into action, on which occasion the guns were distributed in the following way round the square formed by the infantry.

Two 9-prs., two 7-prs., and two Gatlings on the front face; two 9-prs. and two 7-prs. on the right face; two 9-prs. on the rear face; two 7-prs. on the left face.* Disposition of guns.

My division was placed in the centre of the 1/13th L.I. on the right face of the square, and opened fire at 1000 yds. against the Nodwengo Kraal (formerly the residence of the old King Panda), behind the stockade of which the enemy had massed in large numbers. The bullets of the shrapnel not seeming to penetrate the stockade, common and double shell were fired with great effect, driving the enemy into the open. The action lasted but one hour, during which time the guns played unceasingly on the advancing Zulus, who at times came to within 80 yds. of the square.

The number of rounds fired by each gun of Major Tremlett's battery averaged 22. The right division, under Lieut. Davidson, R.A., expended all their case in the early part of the engagement, and had to borrow additional rounds from the left division. Captain Browne, R.A., commanded the battery on this occasion, as Major Tremlett was in command of the artillery of the flying column (four 7-prs., M.L.R., and two Gatlings).

Before closing this paper, I venture to make some remarks on the guns and equipment used during the Zulu war.

1. There is no doubt that all the divisions should have been armed with the 9-pr. M.L.R. gun of 6 cwt., as in Zululand the country is so easy for wheel traffic, that wherever the 7-pr. on the Kaffrarian carriage could travel, there also could the 9-pr. go.

The initial velocity of the 7-pr. is so low (968 f.s.) that shrapnel is absolutely of no use beyond 800 yds. range. The bursting charge of the common shell is so small that on explosion it would not even ignite the dry Zulu huts; and their destructive effect is very insignificant. Fortunately the Zulus attacked in such dense masses, that the shells could not but have the greatest possible effect.

2. The special short friction tubes have not sufficient force to ignite the cartridge, and miss-fires frequently occurred. After the first engagement, I gave orders that in future all the cartridges were to be pricked.

3. The glass tube of the spirit-level of the clinometer is so weak that in every case it was broken before the division had been in the field a month. Clinometer.

In the case of a broken spirit-level, high elevation with the clinometer was given in the following manner:—

One spoke of one wheel was placed as vertical as possible, as judged by the eye. The clinometer was placed against the face of the muzzle in the ordinary way, and the gun elevated until the broad arm of the instrument formed a tangent to the felloe of the wheel at the point where the vertical spoke cut it.

This proved very accurate after the eye had become accustomed to the operation.

---

* (See Colonel Brown's Paper on the march to Ulundi, in April number of the "Proceedings of the R.A.I." p. 154).

The clinometers were carried in leather cases on the waist-belts of the Nos. 1 of sub-divisions.

Axletree-arms. 4. The axletree-arms of the Kaffrarian carriages are too light, and bent very easily when travelling over rough ground. They were frequently set to the proper angle by the farriers, when great difficulty was found in removing the axletree, on account of the quantity of bolts securing it to the bed.

Limber boxes. 5. The bottoms of the limber boxes are not of sufficient strength, the shells in one instance falling through.

Fuzes and rockets. 6. The 9-secs. Boxer time fuzes and the rockets (9-pr. Hale's) invariably burnt short. I attribute this to the climate of S. Africa.

Case shot. 7. The number of rounds of case shot carried is insufficient.

Wheels. 8. The wood work of the wheels supplied with the Kaffrarian carriages and limbers shrunk very much, causing the spokes to fit loose in the gun-metal nave, and the felloes to open out and shrink away from the tire. All the wheels of my division had to be taken to pieces and re-made.

Range table. The following range table was compiled, after careful practice, under the supervision of Major Tremlett, R.A., previous to the outbreak of the Zulu war, and was found throughout to be most correct. It will be seen that it differs considerably from that issued with the gun :—

Range. yds.	Elevation. ° ′	Length of fuze.	Range. yds.	Elevation. ° ′	Length of fuze.
400	0 42	2·0	1300	3 55	8·0
500	1 00	2·5	1400	4 15	8·5
600	1 20	3·0	1500	4 45	9·0
700	1 40	4·0	1600	5 15	10·0
800	2 00	4·5	1700	5 45	11·0
900	2 20	5·0	1800	6 15	12·0
1000	2 40	5·5	1900	6 45	13·0
1100	3 10	6·0	2000	7 15	14·0
1200	3 30	7·0			

MOUNTAIN GUNS IN THE NAGA HILLS, 1879 - 80,

BY

LIEUT. A. MANSEL, R.A.

The Naga Hills lie roughly around N. lat. 26°, E. long. 93°.

This tract of hills, varying from 3000 to 1000 ft. in height, is inhabited by tribes of Nagas, such as "Angamis," "Eastern Angamis," "Shotas," "Rengmas," "Semnas," with various others, too numerous to mention.

These, especially the Angamas (the most warlike), used to make frequent raids on our territory, and, for some years past, a strong force of sepoys and frontier police had been established, as a check, at Samaguting, situated on the northern range of the Angami country.

Two years ago a still further move was made; and a station, situated below their largest village of Kohima, with a political officer, was established in the heart of the country.

This seems to have caused considerable uneasiness to the inhabitants, for having collected a considerable number of fire-arms and ammunition, they, in September last, attacked the political officer, Mr. Damant, C.S., when on a visit to Khonoma, killed him, and cut his escort (about 50 men of the 43rd A.L.I., and Frontier Police) to pieces, seizing their Sniders and Enfields.

Our stockade at Kohima was then beseiged by about 3000 Angamis, until it was relieved by the arrival of Colonel Johnstone and 2000 Munnipoories; the garrison having exhausted their provisions, and being in great straits from want of water.

200 men of the 43rd A.L.I., in an incredibly short time, marched to the relief from Debroghur at a day's notice, and arrived at Kohima the day after its relief. The 44th A.L.I., *en route* to Kabul, were stopped at Gowhatty and ordered to the scene of disturbance; and, early in October, Brigadier General Nation, commanding the Eastern Frontier District, with Captain Williamson, a Political officer, assumed command.

Meanwhile, the Nagas had retired to Khonoma, a strong position on a hog-backed hill, running north and south, with precipitous sides. This hill, by artificial defences, they made almost impregnable.

The Brigadier-General having telegraphed for guns, I was despatched from Calcutta, on 1st November, 1879, with three bombardiers of 16/9, R.A., in command of two 7-prs. (150 lbs.); 100 9-pr. rockets 300 rounds of ammunition, with elephant and coolie equipment.

The route was to Goalundo by rail, Nigriting Ghaut on the Bhramaputra by river steamer, and by march to Suchema, the General's camp, a distance of about 120 miles, the last 40 being hill travelling.

The guns arrived at Nigriting on the 12th November, and there met the elephants and 30 men of the 44th A.L.I., detailed as gunners.

Before daylight on the 13th a start was effected. 18 elephants being loaded with the guns, ammunition, and forge tools, &c. These being mostly small and unaccustomed to government harness could not carry the weights as laid down; and, after being twice unloaded to cross two rivers, Golaghaut, 20 miles distant, was reached at 10.30 p.m. Next day a halt was called, and the loads re-arranged; but, as no more elephants were available, it was deemed advisable to leave 126 rounds and 20 rockets at this base of operations. The two largest elephants being unable to carry the gun and carriage, the former was dismounted and lashed on a pillow on an ammunition cradle, together with two ammunition boxes; the remaining elephants carrying four instead of six boxes. Even thus lightened, the marches, averaging 20 miles, were accomplished with the greatest difficulty; and, when the hills were reached, 12 to 14 hours was the time taken to get over ten miles.

The roads at this part were execrable, and one seeing them could scarcely credit the possibility of elephants being able to travel on them at all; trees had to be felled, roadways sunk, banks cut away, and, on several occasions, bridges repaired. One elephant, loaded with rockets, fell over a precipice, and this shaking impaired their shooting very much.

On the 21st November, Suchema was reached, and on the 22nd the attack on Khonoma took place; no opportunity for an artillery reconnaissance thus being possible. From Suchema to the hill on which Khonoma is situated is about four miles; north of this hill, and separated from it by the Zubya River, is the village of Moyema. This valley, and the lower slopes of the surrounding hills, are in rice cultivation, rising in terraces from three to six feet in height.

Kuki* coolies were provided for the guns, which, under the General's direction, took up a position on the Bassoma Hill, to the enemy's right front, 1150 yds. from, and 200 ft. below, his most northern and strongest work. Owing to the difficulty of taking the guns over the rice terraces, sometimes under fire, they were not in position till nearly 11 a.m., although the start had been effected at 7.30 a.m. Lieut. Raban, R.E., with the rockets, fired from the Moyema hill, at a range of over 2000 yds.

Meanwhile the bulk of the force, about 400 men, had been disposed in the jungle to cut off the Naga's retreat; whilst the storming party, about 200 strong (44th A.L.I., commanded by Colonel Nuttall), attacked up the northern slope of the hill, on which Khonoma is situated.

A suitable position for the guns was observed on the south side, from which the line of the defences could have been enfiladed from a distance of 600 yds. from the southern wall, but it was considered that the time taken to occupy it would delay the infantry attack too much.

---

* A tribe bordering on the Naga country, and mostly subject to Mainpur.

The northern defence of the Nagas consisted of an irregular redoubt, with walls 5 ft. thick (except the south face) of stone, and 14 ft. high, measuring from the outside; a watch tower in the keep commanded a view on all sides. The thickness of the wall being observed through a glass, it was attempted to drop shell just over the wall, and for this purpose common shell, with 9-secs. fuze, was used, and, after the third shot, most of the shell burst in or over the work; the fuzes, being new, burnt with great regularity.

The approach to the walls could only take place directly along the ridge, as the sides of the hill were too steep for infantry to obtain a foot-hold. For about a hundred yards in front, the ground was thickly "panjeed,"* and no approach could be made except over ground on which loopholes were most perfectly directed. Firing was continued until the storming party arrived within 50 yds. of the work, and it was then taken with a rush, with a loss of three men; the last shell fired burst in the watch-tower, and killed the chief directing the defence. As this, the only work taken on the 22nd, was by far the strongest, the effect of the two weak 7-pr. guns from such a bad position, may be considered to have been very satisfactory.

No time for training the native detachments having occurred on the march up, the amount of assistance they gave the two bombardiers in charge of the guns was wonderful. A few casualties occurred to the coolies, from Nagas concealed in the surrounding jungle, but they behaved well.

As soon as firing was discontinued, after the fall of the first work, four rounds of shrapnel were fired at some of the enemy watching our dispositions from high points in the upper works, which dispersed them; the guns were then moved over to the fort that had been taken, as it was observed that the storming party had been checked. This was accomplished with considerable difficulty, owing to a brisk fire and the quantity of panjees that had to be removed before the coolies could proceed.

The southern wall of this fort was a few feet below, and varying from 30 to 60 yds. from the faces of the enemy's next work, and was only composed of boarding and small loose stones, through which a few bullets found a passage, and killed and wounded a few of our men. The enemy's fire was so heavy that for a time no place could be found for a gun to bear on his upper works, which were composed of loose loop-holed stone walls, about 1 ft. 6 ins. to 2 ft. thick. Part of this wall was protected, by a projecting tongue of land, from any position it was possible for the guns to occupy.

The right corner of our position being knocked away, double shell, with R.L. percussion fuze, were directed so as to uncover the left flank of his breast-work; one or two fuzes being not set in action by the 4-oz. charge, 6-oz. was used; and, although the gun recoiled con-

* A "Panjee" is a dried split bamboo, about 1 ft. or 1 ft. 6 ins. long, driven firmly in the ground, with a barb to prevent removal, and then sharpened to a point; about four go to the square foot; and it is impossible to walk through them without getting tripped up and spiked. Longer natures are sometimes concealed in pits, on roads, approaches, &c.

siderably, no harm was done, and the shells burst; about two yards of the wall was knocked away, but the enemy threw in thick bullet-proof boards, of which they kept a very liberal supply under their works. Shrapnel with percussion fuze was then employed, which, bursting on impact with the planks, stopped the enemy's fire from this part of the work. An opening was then made in a more central position, but the wall being of loose construction came down and made a wide opening; from this the lower right flank and the right and left flanks of an upper work could be seen. The same projectile was used, viz., double shell, until an opening was made, and then shrapnel with occasional case, when the men shewed themselves, building up the chasm with boards.

The 44th A.L.I. stormed three times in a most gallant manner, but being only able to advance two or three abreast, were driven back by the enemy, protected from the gun by the tongue of land already mentioned. Their fire at such close quarters, from as many as they could use out of the 400 guns in their possession, with clouds of spears and rocks, was naturally very destructive, and we soon had to mourn the loss of two officers mortally, one severely, and one slightly wounded; 22 men killed, and 27 wounded; something like 25 per cent. of the whole party.

In the last assault, the storming party being checked, the enemy began to line the walls from which the gun had driven them, but the "lie down" having been sounded by the gun detachment bugler, a few shell, with percussion fuze, fired two feet above the heads of our men, drove the enemy back, and they were able to retire without further loss.

The enemy being hemmed in by our troops in the jungle, fought with great desperation, though, at the beginning of the fight, they had tried to retreat until driven back by the fire of a party of our men who occupied a "sunga," which they had captured in rear of Khonoma. A few more rounds were fired, but darkness came on, and the "assembly" having sounded, we occupied ourselves in fortifying our position (the enemy, some 3000 strong, being within 50 yds.) and burying the dead; the troops suffered greatly during the night from the cold and want of food and water.

The enemy evacuated in the night, and the whole range of their positions were occupied by us at daybreak; wall within wall lined with loopholes, and the flanks protected by cliffs, rendering a turning movement impossible. The Naga's tried to draw the fire of the guns from certain places by planting spears, so as to shew just above the wall, but without success.

A large quantity of shell fragments and shrapnel bullets were found inside the works; but the Nagas had removed their dead in the night. The traces of blood make it appear probable that their loss must have been severe, although the full effect of the shrapnel must have been modified by large piles of rice lying about. Some chatties* on the terre-plein of their works were riddled with bullet holes, and thick wooden troughs, used for pounding the unhusked rice, were stretched

* Earthern vessels.

across the line of fire, evidently having been used as cover to lie behind.

One of the rockets from the Mozema Hill, at an early stage of the engagement, set the lower part of the village on fire; but, as a rule, they acted very irregularly, which may be attributed to the severe shaking they received *en route*, as they were Mark III, and, at a previous trial on the river, acted well.

On the 26th, the guns accompanied a column of 250 men against the the enemy at Jotsoma, but they made no stand; after which they were not concerned in any operations until the 1st of January, 1880, when a move was made against the village of Cheswedjuma, in the eastern Angami country.

Kachar coolies were provided for the guns, and Nagas for the ammunition; the former are weakly men, and utterly unsuited for the hills, whilst the latter, though strong and athletic, will not carry from the shoulder; and, when firing takes place, invariably throw down their loads and take to the jungle; the collection of the ammunition boxes after such an occurrence is rather an unpleasant duty. Fortunately, Nagas, though perfect skirmishers, do not care about coming to close quarters unless behind walls, for if such were not the case, I do not see how it would be possible to prevent the loss both of guns and ammunition in such extremely difficult country where, in many places, the track runs through narrow defiles, with sides inaccessible to anything but a Naga or a monkey.

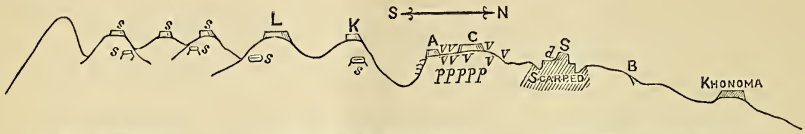
Although four coolies per gun, and six per carriage, were detailed, the three marches to Cheswedjuma were much delayed from the inability of the coolies to carry their loads with moderate celerity up the precipitous slopes and through the difficult country traversed. A Naga road, as a rule, running straight up and down the hills, which, being mostly clothed with the densest jungle, renders flanking parties impossible.

Cheswedjuma was occupied without opposition; four rockets were fired into neighbouring valleys to clear them of the enemy. When the work of destroying the village was nearly complete, the enemy came through the burning village, and with rifles began to annoy our troops, but a couple of shrapnel burst in front of them made them fly to the jungles. Only two men were slightly hit, although, from a flanking party being withdrawn too soon, some shots were fired from behind cover at the guns from a distance of only 50 yds. Fortunately, they were Enfield bullets, and not handfuls of slugs, which it is a Naga's delight to discharge from an old brown bess.

No further artillery operations took place, and the march back through the villages of Tenedjuma, Kekrima, Kedima, Ksinema, Jakoma, and Phesema, was through a most wild and picturesque country, which there was plenty of time to admire, as the gun coolies could make only about eight miles in 12 hours.

The defenders of Khonoma had in the meantime occupied an almost inaccessible position at the back of Khonoma, consisting of a series of conical peaks ending at the northern extremity in a hill, *AB* (see rough sketch), with a narrow-topped ridge, the beginning of the southern slope of which was about 1600 yds. from our stockade at Khonoma. This ridge was about 1500 ft. above it. Their defences

consisted of detached stone forts, and surrounded by innumerable obstacles.



SB = 300 yds. *LKC* Large stone forts. *ssss* Numerous sungas.
vvvv Site of temporary village. *S* A thick stone screen.

Their temporary village was on the narrow-topped ridge, on the sides of which a large open basin extended, whilst on the east ran a parallel hill (the Bassoma) about the same height as *AB*, with a point on it about 1500 yds. distant from *C*, too great a range for accurate practice with the light 7-prs. Position *B*, where it was proposed to construct a sand-bag battery for one gun, was rendered useless except from high-angle fire (the hill being about 20 yds. broad at *B*, tapering to about 10 yds. at *S*) from the fact that the enemy, taking a lesson from the action of Khonoma, had constructed a screen (*S*) about 7 ft. high (the hill being carefully scarped on each side), made of huge boulders, 6 ft. thick at the top, and 8 ft. at the base. This was surmounted by a quantity of prickly-pear bushes, and rude fraises to prevent escalade. From the back of this screen to their first fort (*C*) ran a covered way, whilst a single plank over a chasm (*d*) entered its mouth. The eastern and western side were precipitous, whilst at *A* the steep slope was heavily "panjeed," and strewn with abattis, and surmounted by a stout loop-holed stone wall.

The stone fort *K*, from its position, would have made *AC* untenable had it been captured, and had it then been possible to take the guns there—a matter of grave doubt, owing to the precipitous nature of the hill on all sides. The rear of the position was protected by an inaccessible mountain 9000 ft. high. Few, indeed, could be the positions so naturally strong, and still fewer could have been better strengthened artificially. The few goat paths leading anywhere were occupied every 200 or 300 yds. by small sungas, and wherever steps were used, planking, tied by cane, and supporting many tons of large rocks were suspended. The cutting of the canes, after we occupied the position, gave a very fair idea of what the effect would have been on advancing troops.

Meantime, awaiting the arrival of reinforcements, a blockade as rigid as the numbers of our troops would allow of was maintained, and a position for the guns was prepared on the Bassoma ridge, the intention being to send one to *B* before the assault. From this it was proposed to shell the enemy whenever he showed, and to annoy him and render rest impossible by a shell and rocket every half-hour or hour during the night. The guns were marched for this purpose to Jokoma, about half-way. A wing of the 18th N.I. arrived at Suchema the same day.

On this date, however, the enemy sent in an embassy, and accepted our terms. These involved the surrender of 200 guns, a fine of 1500 rupees, the building of their villages in valleys instead of inaccessible hill tops, and that the site of Khonoma and its rich rice fields should be confiscated, whilst the three Keyls (clans) of the village were to be settled in different parts of the country.

In no campaign could greater difficulties have been encountered, as the expedition started with practically no transport, it being presumed that the so-called friendly villages would supply the necessary transport. The help they afforded was considerable, but was of a most uncertain character.

After the Khonoma affair, considerable loss happened to our men from Nagas creeping up and shooting sentries, and also from continued ambuscades, rendered successful from the impossibility of having flanking parties, owing to the thickness of the jungle, and the steep nature of the ground bordering every track. A more demoralizing description of fighting to troops it is hard to imagine. The Nagas' tactics on these occasions was to build a light stone wall, concealed perfectly in the jungle, about 30 or 40 yds. from the road, fire a volley of slugs at our men toiling in single file, and then disperse in the jungle, in which their activity rendered pursuit hopeless. Our loss during the eight months the campaign lasted was very heavy, and though I have not the exact figures by me, it was something like 150 killed and wounded out of the 600 men actually at the front. By far the heaviest losses occurred among the men of the 44th A.L.I., upon whom the brunt of the fighting fell. About half the force engaged in the campaign was employed in protecting the long and difficult line of communication to Golaghaut, whilst other available troops were posted in Cachar, &c., to protect the tea planters, &c., there.

Heavier guns would have, of course, been much more desirable, but the difficulties of transport were so great that it would have been scarcely possible to have added another pound of weight unless a proper coolie corps of "Bhooleahs," or "Kukes," say, had been maintained. To move the guns, the 300 rounds of ammunition, the 100 rockets, with forge tools, &c., it would take 160 coolies, such as provided, and these would occupy on the march, with an escort of 50 men, very nearly a mile on the ordinary country road. Except Kahars (the ordinary dhoolie bearer), no coolies that I have experience of, carry, naturally, loads suspended on bamboos resting on their shoulder. The two Nagas detailed to each ammunition box always preferred taking it in turn on their backs to using the carrying bamboo, and this was objectionable in rainy weather, as water sometimes entered between the cover and side of the box. Each box, weighing as it does about 86 lbs., is too heavy a load for a single coolie; whether it would be worth while to construct a box weighing, with ammunition complete, about 60 lbs., is a matter for consideration; it certainly would save a large number of coolies, but, on the other hand, in most countries where guns would be required, mules would probably be able to be used, which could not have been done in many places in the Naga Hills.

A difference with the village of Kohima was settled by two rounds of common shell, which killed two men and a cow, at a range of 1300 yds.; the gun was worked and ammunition prepared by the native detachments. Practice with plugged shell was made at Kohima against a fort 10 yds. square, over a screen, such as at *S*; at a range of 300 yds., with an average elevation of $15\frac{1}{2}°$, and a charge of 17 drams, about 30 per cent. of the shot fell in the fort. No tables for curved fire for these guns seem to have been drawn out.

Notes on Nagas.

Nagas are a powerfully-built clean-limbed race, of a slightly Mongolian type of countenance. They appear to be adepts at all arts of deception. They live in substantially-built houses, and their system of watering their terraced cultivation cannot but create feelings of respect for their capabilities, and why otherwise they should be such utter savages seems extraordinary.

Each village is independent, its inhabitants generally wearing a cloth of different colors to distinguish its men from the others. No man is above his fellow, and a purer form of democracy than their government could not be conceived.

The villages are almost without exception situated at the top of steep hills, and are surrounded by escarpments, narrow deep lanes closed by doors being the only entrance into them.

Their habits are dirty to a degree, and as every village is nearly sure to be at war with some other, their large herds of cattle, together with droves of pigs, have to be collected in the village every night.

The food they use is mostly rice, but on great occasions eat cows, dogs, rats, and vermin. They do not use much water for drinking purposes, for each individual carries a huge gourd of zoo, a fermented liquor made of a species of millet; in taste it is like a very inferior claret.

A Naga's (though by no means as a rule a plucky individual) sole idea appears to be the collection of the heads of his enemies. On the completion of a successful raid, the heads are brought in, and a dance in full war costume takes place round them. The dance is a most complicated species of lancers, in which everyone knows his part, accompanied by a low monotonous chant, broken occasionally by hideous screams and barkings like a dog. Warriors spring about with great agility, brandishing their gun or spears, and waving their tiger or bearskin shields. For dress they wear a black cloth kilt, on which they sew a line of cowries, up to four rows, for every man, woman, or child they kill. In cold weather a cloth, something like a Roman toga, is worn. The upper part of their ears is furnished with lumps of cotton wool, whilst from the lobe depend ear-rings of human hair dyed crimson, and fastened by the tusk of a wild boar.

The Eastern Angamis also wear scarlet basket-work leggings, which are made on the leg. Each man's great idea is to possess a gun, and the number of them in the country is very considerable.

The dress of the women differs but slightly. Those that are unmarried are compelled to keep their heads shaved; they do most of the hard work.

In their own country Nagas are the perfection of skirmishers, and the heavily accoutred Goorkas are no match for them except that whatever their loss may be they go on till they drive them back.

The warriors have a species of Victoria Cross, given to very successful murderers. It consists of a 6-in. square of boarding, covered with cowries, and surrounded by human hair, hung round the neck by a cowried belt, with a hair fringe. One of our allies, a small quiet-spoken man, was credited with the death of 70 of his neighbours.

Rawul Pindi,
June, 1880.

KRUPP'S MEPPEN EXPERIMENTS OF 1879.

BY

CAPTAIN C. ORDE BROWNE,

Late Royal Artillery.

(*Re-printed from the Journal of the Royal United Service Institution.*)

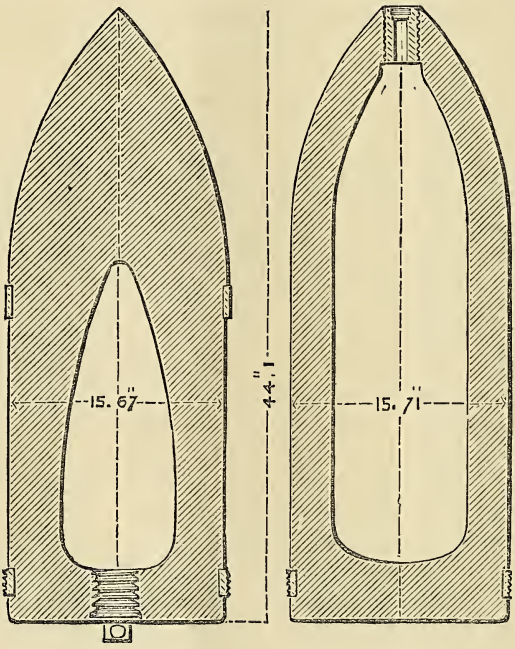
The purpose of this paper is to take a short review of the most characteristic features of the Krupp *matériel* experimented on at Meppen last summer, calling attention chiefly to the best results, and comparing them with corresponding ones obtained in this country, with a view to promote the discussion of those matters in which it may appear that we have most to learn.

The principal feature in the Meppen programme was the trial of Krupp's 40^{cm} (15·75-in.) breech-loading gun, weighing about 70 tons 17 cwt., known commonly as the 71-ton gun. The trial was specially important for three reasons:—1st, it is the first breech-loader whose power approaches that of the 100 and 80-ton guns made in this country; 2nd, it is a steel gun; 3rd, its proportions are based on results obtained during the last few years.

All these questions are interesting, and deserving of so much attention that it would be difficult here to deal fairly with all. For the purpose in hand, however, it is not necessary to discuss the question of the respective *metals* of the guns, because it can easily be shown that there was nothing in these experiments that bears upon this point beyond the negative fact that the steel guns in no respect exhibited any fault. We may safely say that our Woolwich guns would have done equally well, as far as the material is concerned, for the pressures in Krupp's guns were by no means excessive. The 71-ton gun, for example, was not subjected to as high a pressure as our own 80-ton gun has borne. A test which tries neither gun obviously furnishes us with no means of comparison, and hence the Meppen trials in no way furnish data for the discussion of the relative merits of wrought-iron and steel guns, but bear entirely on the two other questions, namely, that of breech-loading and proportions—the former as concerns ease in working, and the latter power and good shooting.

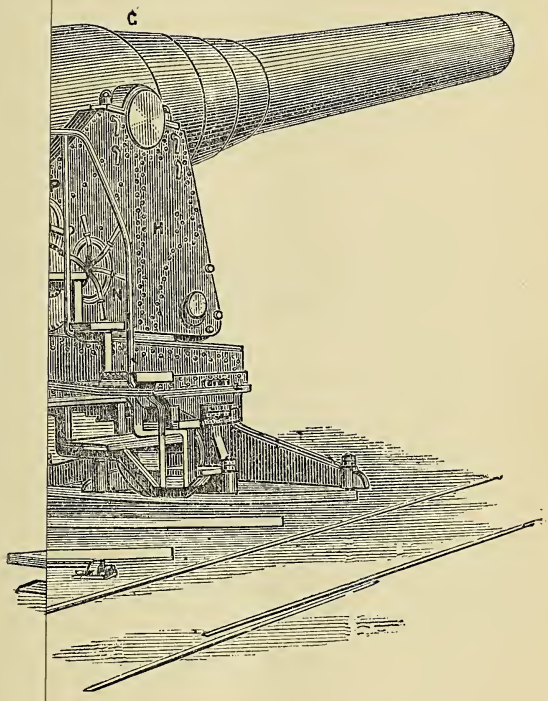
The 71-ton gun (Fig. 1), was mounted as for coast defence, on a traversing platform, and a carriage nearly of the English pattern in all

respects. The brackets were made of wrought-iron, the gun being elevated by multiple gear, *N*, acting on elevating arcs, *O*, fixed on the gun. Beneath the carriage were two hydraulic buffers. A modified form of Cunningham's chain-gear, *RR*, was used for traversing the platform, which ran on trucks on three concentric racers, the pivot being about 6 ft. in front of the carriage when run up. A lifting crane, *J*, was attached to the platform, fixed on a sort of axle, *K*, with a counter-lever with powerful spring, *L*, which required considerable force to compress it by bending down the crane, and which decreased the work of lifting the projectiles by the same amount, thus dividing the labour of lifting the projectiles into two operations.



15·75-in. (40cm.) Chilled Shell.		Common Shell.	
Weight of shell, empty	1,690·6 lb.	.....	1,338 lb.
Weight of bursting charge	22 lb.	.....	73 lb.
Weight of shell, filled	1,712·6 lb.	.....	1,411 lb.

The gun was easily worked by a detachment of 15 men. Ten rounds, with chilled projectiles, were first fired; the time occupied by the last five rounds was 24 minutes. The breech-piece moved easily. A good deal of oil was used on it. The breech-loading certainly saved the men much labour, not only in the actual ramming home, but also in bringing up the projectiles, since it was not necessary for them to cross any of the racers or the Cunningham chain. The charge was made up in four cartridges, each containing 110 lbs. of prismatic powder. The least satisfactory part of the service of the gun was the



nd wheel for elevation with train of wheels working on
A— toothed elevating arc O.
B— aduated disc, showing quadrant elevation, being set by
D reverse (inner) edge of elevating arc.
E Q Q—Handles for working traversing gear.
F

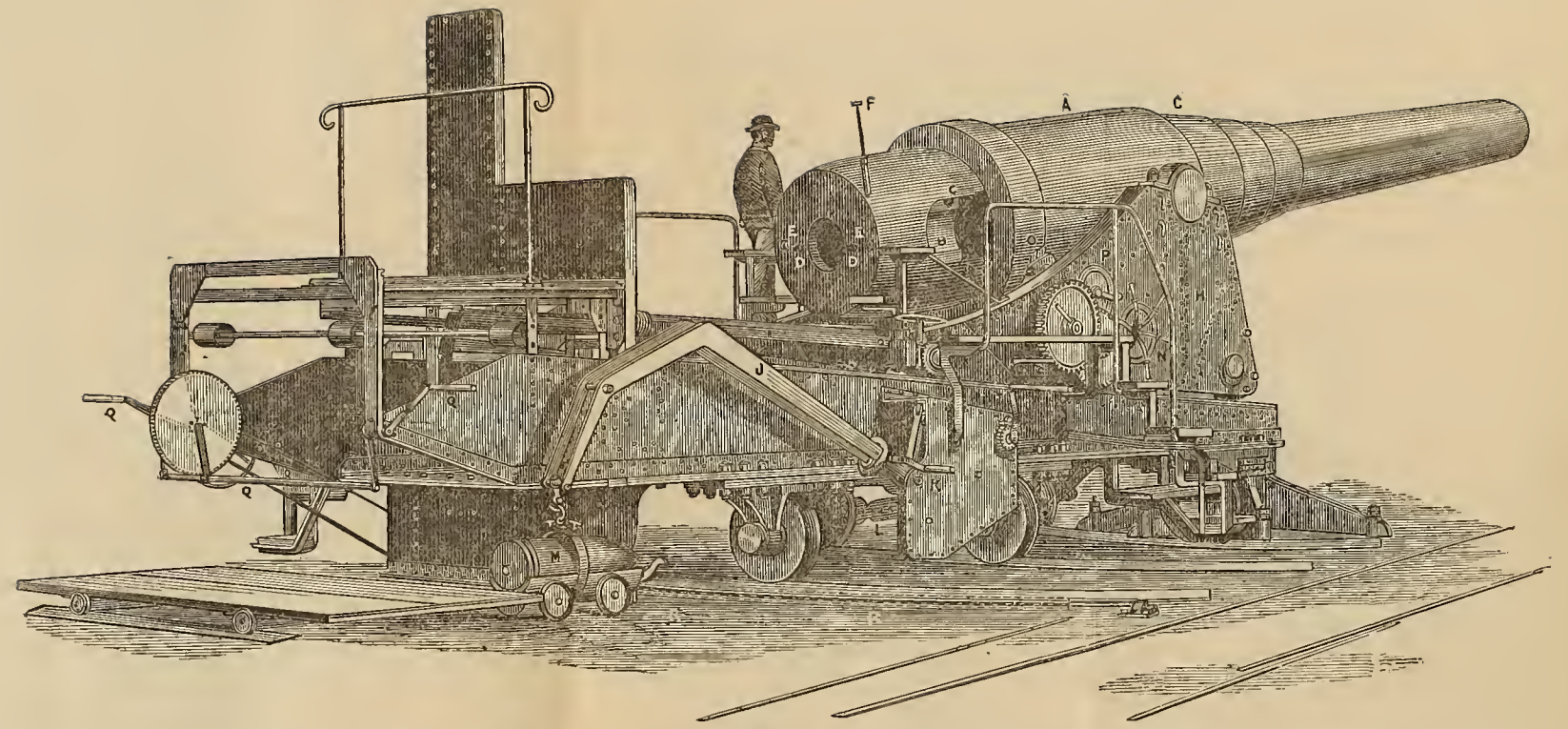
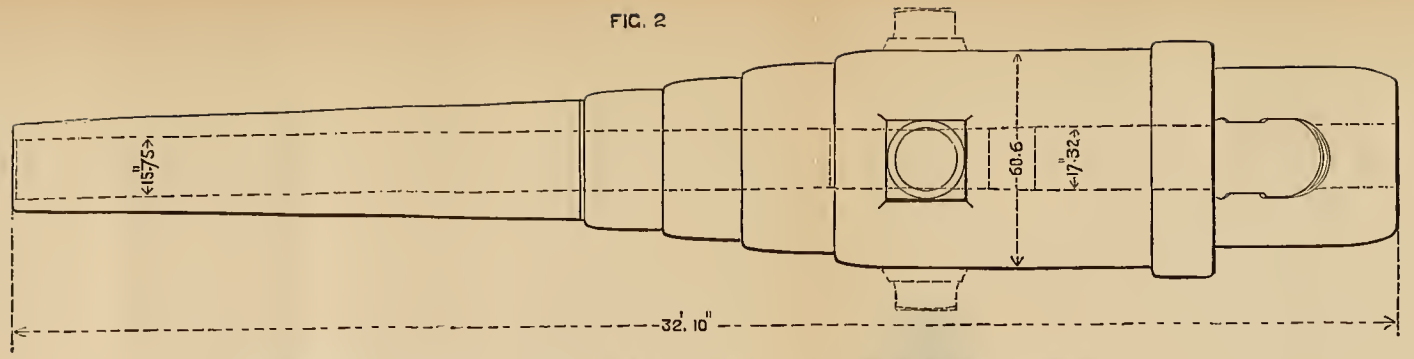


Fig. 1.—16-IN. (71 TONS) GUN MOUNTED ON COAST-CARRIAGE.

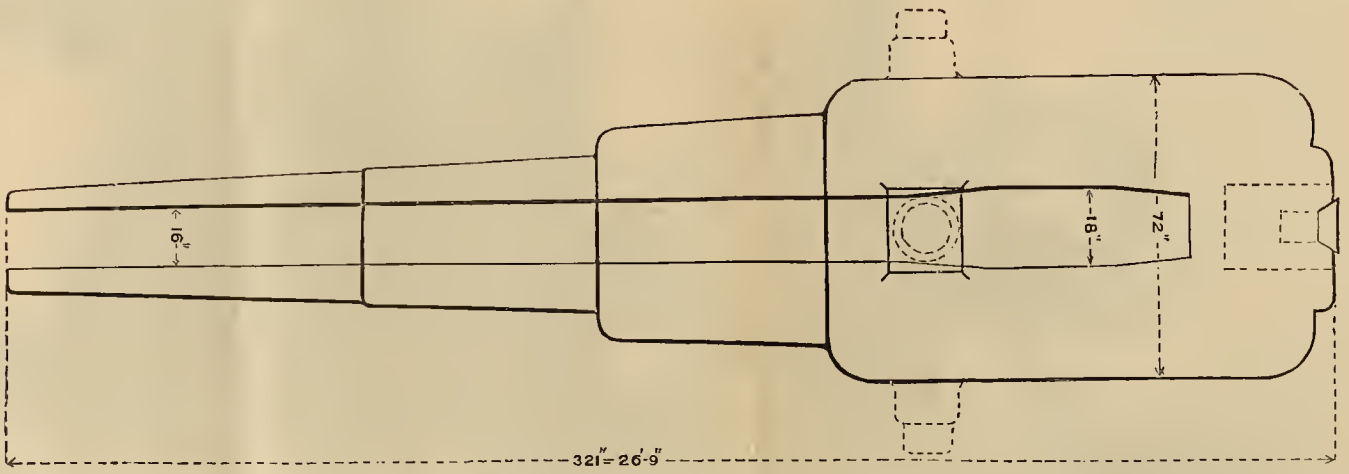
A—40 centimetre (15·75-in.) gun, length, 32 ft. 10 in.
B—Breech-closer, showing C end of driving screw.
D D—Studs for hooking on shot guide.
E E—Rings for rammer pulley blocks.
F and G—Tangent and trunnion sights.
H—Carriage, wrought-iron.
I—Loading platform.
J—Crane, pivotting vertically on pillar hinged horizontally at K, with counterspring on arm L beneath the carriage.
M—Cbilled iron projectile.
N—Hand wheel for elevation with train of wheels working on toothed elevating arc O.
P—Graduated diso, showing quadrant elevation, being set by reverse (inner) edge of elevating arc.
Q Q Q Q—Handles for working traversing gear.

FIG. 2



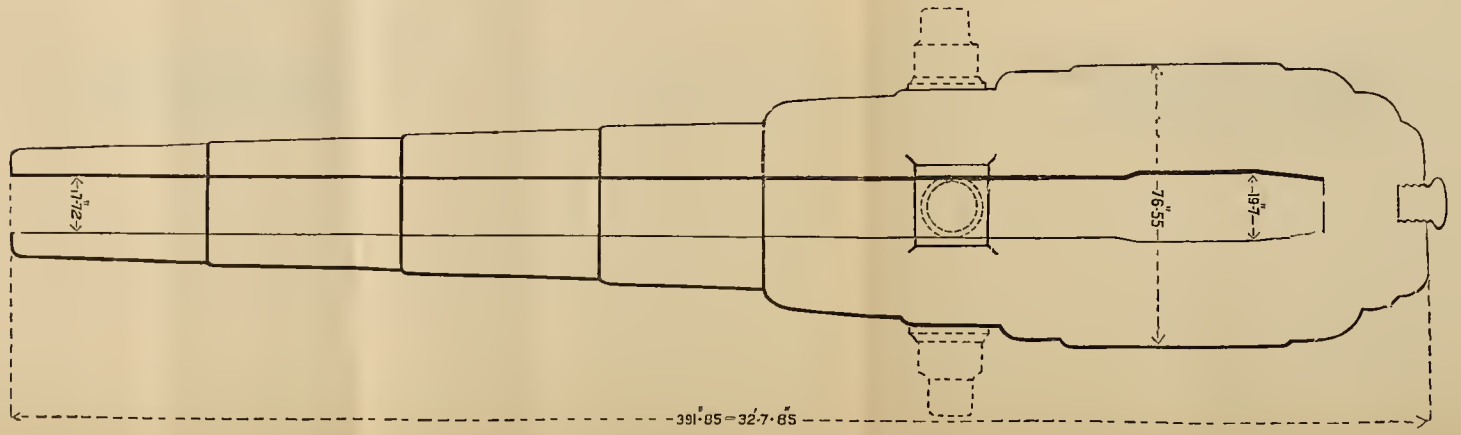
KRUPP'S 15·75-IN. (40 CM.) 71-TON GUN.—WEIGHT OF GUN WITH WEDGE ABOUT 71 TONS.

FIG. 3.

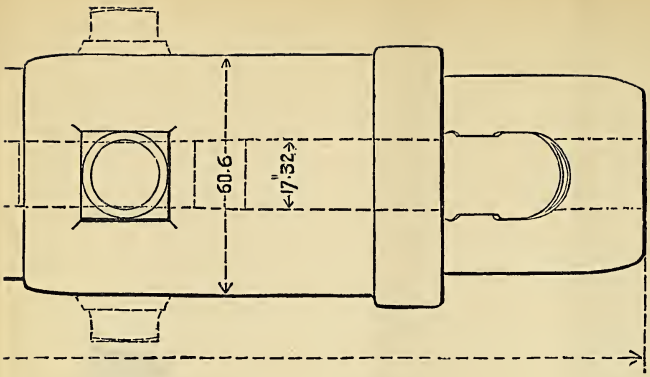


WOOLWICH (16-IN.) 80-TON GUN.

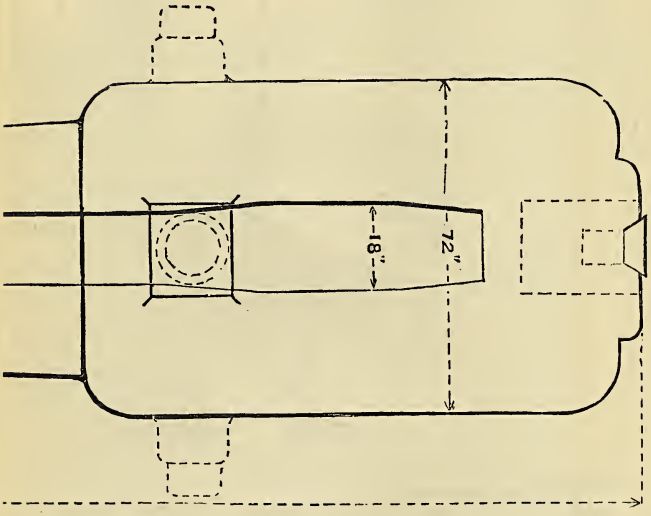
FIG. 4.



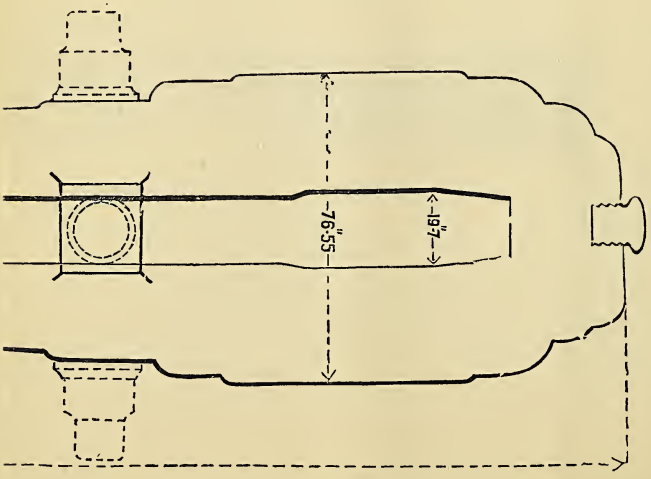
ARMSTRONG (17·32-IN.) 100-TON GUN.



ITH WEDGE ABOUT 71 TONS.



N.



UN.

difficulty experienced in the ignition of the charge and in remedying miss-fires. The vent was in the axis of the piece, and a disc of calico was torn off the bottom of the cartridge last entered, to expose the powder to the flash of the tube. The latter was of a bad pattern, short and weak. No stress is to be laid on this, as the remedy is obvious. A primer or a stronger tube would rectify this fault. A rather more serious difficulty was apparent when a miss-fire had occurred. The position of the vent was such that it was unusually dangerous to approach it while there remained any likelihood of the gun firing. A gunner may insert a tube in a vent in the top surface of a gun with comparative safety, but to thrust his hand into the cavity in the breech, and in such a position tamper with a doubtful tube and charge, would indeed be dangerous. On active service the risk, no doubt, would be run, and it is possible, if the man stood on the step of the carriage and reached round so that the gun in any unexpected recoil should carry him with it rather than run over him, that he might escape without injury. Nevertheless, while this modifies the objection, it remains sufficient to make it imperative to construct some implement to enable a tube to be removed and another entered with safety, even should a miss-fire be a much rarer occurrence than it was at Meppen last summer. The flash from the vent has been spoken of. This is an objection which belongs to all axial-vented guns. In Krupp's guns, there was but little flash at Meppen, owing to an arrangement by which a loose platinum ball in the vent is driven up out of the way by the flash of the tube, but pressed back so as to close the vent by the rush of gas from the charge. An Italian officer stated that this ball is not serviceable, but becomes worn and of little use after a time. Under any circumstances this difficulty is one connected with axial vents rather than breech-loading.

A more important question is the shooting of the gun as regards power and accuracy. The chilled projectiles had 0·078 in windage, which is about the same as that in Woolwich projectiles, namely, 0·08-in. over a copper rim. The common shell subsequently fired, however, had the unpractical windage of about 0·01-in. over an iron body.

The diagrams, Nos. 1 and 2, show a remarkable degree of accuracy, chiefly in the vertical direction, which argues well for the regularity of

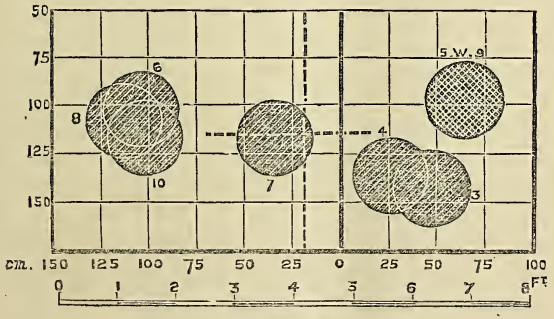


DIAGRAM 1.

Group of hits on target made by 71-ton gun at 2,734 yds. range.

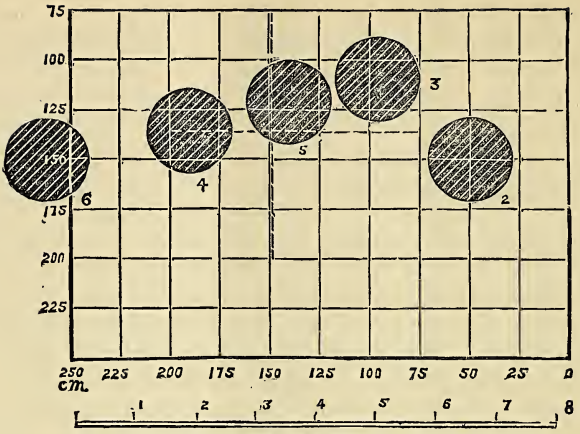


DIAGRAM 3

the charge, which has been attributed to the prismatic powder employed. But while the regularity of the powder is a necessary element in such a result, I cannot see how it *alone* explains it. The effect of variation in powder doubtless would be seen in the deviation of the shot in the vertical direction only, but it appears to me that bad shooting from the faults in the bore of the piece would be seen in irregularity both in the vertical and horizontal direction. If the vertical deviation is very small, then it argues not only that the powder was regular but that the bore also carried true to within the limit exhibited, and a cause for the error in the horizontal direction must be sought elsewhere. With regard to the powder, it stands to reason that a charge composed of a fixed number of prisms of uniform size and density gives promise of greater uniformity being attainable than when pebbles are employed; and there seems no reason to doubt that whatever difficulties were at first experienced this has been achieved. Surely if two attempts are made to obtain regularity in powder—one by employing prisms each uniform in size and shape, and if possible pressed uniformly, and another by means of pebbles of a accidental shape from uniformly pressed powder cakes—the former, though it may be difficult, offers promise of ultimate success in the higher degree. As to the windage, stress can hardly be laid on the great reduction in the case of the common shell; the two kinds of projectiles made pretty nearly equally good practice. Lastly, *as to the proportions of the bore and chamber.* The most striking feature is the length of the bore. Figs. 2, 3, and 4 show the relative lengths of the best heavy guns at present in existence, by which it appears that the bore of the 71-ton gun is only 20 ins. shorter than that of the 100-ton gun, and 55 ins. longer than that of the 80-ton gun. The chamber in length is 60·6 ins., that of the 100-ton gun being 59·7, and of the 80-ton gun 59·6. The calibre of the 71-ton gun is 15·75 against 16 in the 80, and 17·72 in the 100-ton gun. Consequently, the bore of the 71-ton gun is 21·8 calibres long against 18 in the 80, and 20·5 in the 100-ton gun. The

diameter of the chamber of the 71-ton gun is 17·32 ins., that of the 80 and 100-ton guns being 18·0 and 19·7 ins. respectively, that is to say, it is 1·57 ins. greater than that of bore as compared with 2·0 ins. increase in the 80, and 1·98 ins. in the 100-ton gun.

Speaking generally, then, the bore of Krupp's gun is relatively rather longer, and the chamber less enlarged than in the 100-ton gun, while in the 80-ton gun the bore is actually the shortest, and the enlargement of the chamber actually the greatest of the three.

It should be understood that our own investigations have led to the adoption of far greater length of bore than is exhibited in any of these three guns. I am informed that a B.L. gun of 40 tons, 26 calibres long, is in course of construction. I am speaking, therefore, of the 71-ton gun which was made last, simply as having actually *embodied in it* a further stage of progress than the 80-ton gun. The first gun with an enlarged chamber, that I know of, was a field gun fired by Sir J. Whitworth at Southport in October, 1872.

On the proportions of bore and chamber mainly depend the power of the guns. To be able to make a comparison between them, discrimination is necessary. It would not be right to take equal or proportionate *charges* as the basis of the comparison, because the principle on which a long gun is advocated is that any greater result can thus be got from a gun with a given strain on it, but at the expense of some waste of powder.

It is clear, then, that looking to the endurance of the gun rather than the expenditure of powder, the basis of comparison should be *proportionate pressures*. It would scarcely be right to say *equal* pressures, because the thicker gun can fairly be expected to bear a greater strain than the thinner one. Now, the best results obtained from these three guns are as follows :—

The 80-ton gun at Woolwich with a proof-charge of 445 lb., giving a pressure of 21·5 tons, discharged a projectile weighing 1728 lbs., with a velocity of 1658 f.s.—having 32,938 ft. tons stored-up work, or 658·57 ft. tons per inch circumference—equivalent to a penetration of a 32·34-in. plate of wrought-iron. The 71-ton gun at Meppen is reported, on one occasion, with a charge of 485·1 lbs., giving a pressure on the gun of 20·92 tons, to have discharged a projectile weighing 1715 lbs., with a velocity of 1703 f.s.,—having therefore 34,489 ft. tons stored-up work, or 697·02 ft. tons per in. circumference—equivalent to the penetration of a plate 33·5 ins. thick.

During the public trials in August, the 71-ton gun was not tested so severely, and it is therefore right to class the above in the same category as the Woolwich proof-round above mentioned. In August the average weight of the chilled projectiles was 1712·6 lbs. The firing charge was 452 lbs., the initial velocity was 1648 ft., the stored-up work 32,241 ft. tons—the work per inch circumference 651·59 ft. tons, equivalent to a penetration of 32·12 ins. The pressure on the bore was 19·85 tons.

The highest result obtained with the 100-ton gun of 17·72 ins. calibre, hitherto, has recently been furnished me by Captain Noble; it is as follows :—charge, 573 lbs.; projectile, probably about 2,000 lbs.;

velocity, 1725·5 ft.; stored-up work, about 41,290 ft. tons, or 745·07 ft. tons per inch circumference, equivalent to a penetration of over 34·9 ins. of armour. The pressure on the bore was 17·6 tons.

It is quite clear, from the above, that the 71-ton gun is a much better weapon than the 80-ton gun, inasmuch as it beats it in every respect. It fires a heavier projectile with a higher velocity, which has therefore more energy or stored-up work, and an inch and a half more penetration, and all this is done with less pressure on the bore of the gun. The reason is that it is a better proportioned gun, its main advantage being its greater length. The 100-ton gun compares much more favourably with Krupp's gun, but, nevertheless, would do so better if its length were greater. The main difference in the guns depends on the difference in the length. Comparing these three guns together, I must remind you that the 100 and 80-ton guns are productions of an earlier date than the 71-ton gun, and the latter *ought* therefore be better proportioned. I am not speaking, then, of any superiority in knowledge shown by Krupp; on the other hand, I am anxious to do justice to the labours of General Younghusband and Captain Noble in making investigations on this question, which the artillery world generally has turned to good account. Speaking, then, not of the knowledge but of the embodiment of it in new guns, the question naturally arises, how it is that our Government should be now completing and issuing 80-ton guns so inferior in power to Krupp's 71-ton gun, which achieved the results we speak of half a year ago? The answer is, that the guns are designed for the "Inflexible," and that, being muzzle-loaders, the vessels had to be made with portions of the deck corresponding to the length of the gun, to make provision for its loading. All this was determined five or six years ago. Since that time *our own investigations* have shown us the desirability of greatly increasing the length; but the gun being a muzzle-loader, it is impossible to do so. For the ship in question, a muzzle-loader is limited as to its length by inflexible conditions; and all that can be done is by enlarging the chamber, to utilize to the fullest extent the disproportionate thickness of metal. Circumstances have, in this instance, then, combined so as to bring out the disadvantage of a muzzle-loader in a peculiar way; for we find ourselves, in the case of the "Inflexible" issuing new guns of obsolete proportions for a new ship. Apart from this trying instance, however, it is clear that every increase in length is in favour of the breech-loader, because the labour and inconvenience of muzzle-loading increase in an increasing ratio; and, in the case of turret guns, and probably in some guns in casemates and cupolas, muzzle-loading with long guns becomes eventually almost impossible.

To pass from this principal experiment to minor ones at Meppen.

Very remarkable results were obtained with smaller guns. An excellent 51-ton 14-in. gun was tried, whose behaviour closely resembled that of the 71-ton gun, including the method of working, occasional miss-fires, and the like. An 11-in. (28^{cm}) howitzer, a 4·13-in. (10·5^{cm}) siege gun, and a 3·78-in. (9·6^{cm}), were fired, which did well, but need not be here noticed in detail.

A long 5·9-in. (15^{cm}) gun, on a special sea service carriage with oil buffer gave good results; also an 8·27-in. (21^{cm}) howitzer, and a 5·9-in.

(15cm) mortar, were fired at dummy guns in a battery with good effect, notwithstanding that some of the fuzes failed to act.

Two remarkably characteristic guns, 3·4-in. (8·7cm) were fired, fixed on pivots, one with little, and the other with absolutely no provision for for recoil. With these is naturally connected another non-recoil arrangement of Krupp's now well known, consisting of 6·1-in. (15cm) gun, muzzle pivoting, the muzzle being ball-shaped and working in a socket in an armour plate. These three guns possess peculiarities deserving of attention.

One piece, 3·4 ins. in calibre, Fig. 5, was 14 ft. 3¼ ins. long. Its

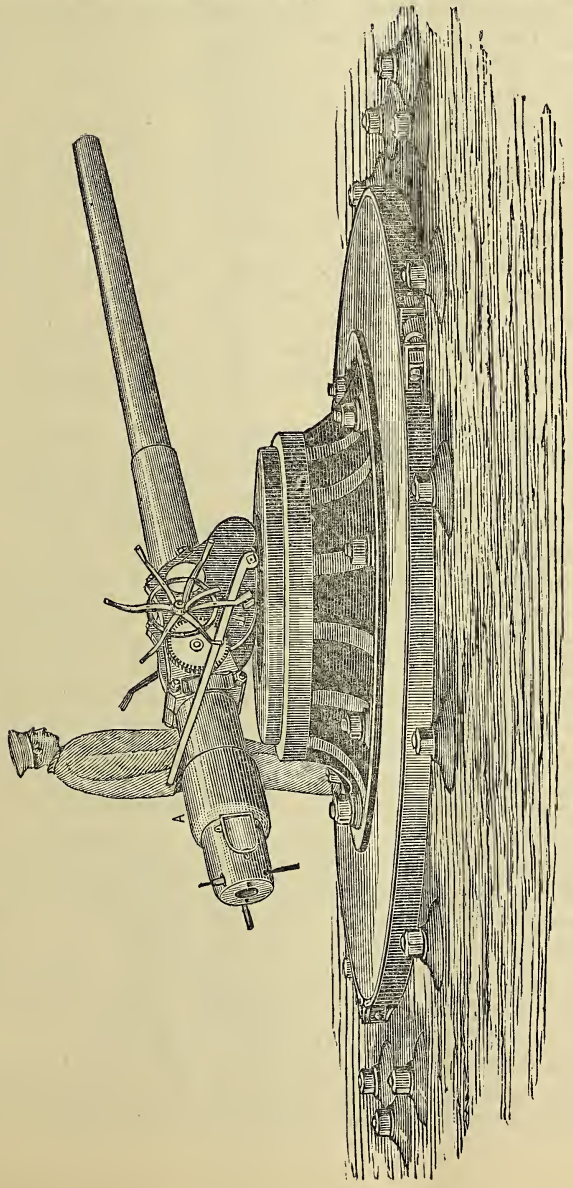


Fig. 5.—Krupp's long 3·4-in. (8.7cm) trunnion-pivoted gun fixed, without recoil.

chamber was enlarged to an extraordinary extent, being 5·9 ins. in diameter. The cartridge was a long bag, very loose on the powder, made so as to admit of being adjusted in the chamber by hand. The charge was 7·7 lbs. Two kinds of projectiles were fired—long ones, 12·5 ins. in length, weighing 22 lbs., and shorter ones, 9·5 ins. in length, weighing 15 lbs. The initial velocities of these projectiles were 1829 and 2098 ft. respectively. The maximum pressure was 11·6 tons. During this extraordinary performance, the gun was held rigidly, being fixed on a strong vertical steel pivot, and so steady was it, that small coins placed on its barrel where not shaken off on firing, except near the muzzle. Eventually a Dutch officer displayed sufficient confidence to sit astride on the gun while it was fired, with the projectile shooting between his legs at the rate of about 2,000 ft. per second. May I call your attention to this piece as an extraordinary experiment as to the effect of long bores and enlarged chambers. The bore is nearly 47 calibres long, the chamber is 1·73 calibres in diameter, the capacity of the chamber being, in fact, three times that of a portion of the bore of similar length. The penetration of this piece with projectiles of the weight of the longer shell would be 6·25 ins. of iron. It weighs nearly 25 cwt., and is intended for a pivot gun. It is nearly equal to the penetration of parts of the "Hercules" and "Sultan" class of armour.

The second 3·4-in. gun somewhat resembled the above, but had provision for slight recoil, the pivot moving on its lower end as a centre, the gun forcing the upper end back against a piston or buffer.

The muzzle-pivoting 6·1 in. gun, Fig. 6, was worked easily, the armour absorbing the shock of recoil, and suffering in no way apparently beyond the structure appearing to spring a little in the earth. A man laid it while riding on a saddle placed on the chase of the piece; he employed sights directed through a small hole at a convenient height above the gun, and he fired the gun himself by pulling the lanyard while still sitting on the piece. This system has been tried by one Government experiment, but has not hitherto found favour. It certainly appears as if a heavy gun so fixed to a shield, and impressing its work on it every round, must soon destroy the structure, but apparently it would take a very long time for a medium gun to do so; and it is possible that a gun so completely protected, and able to fire with such great rapidity, might perform admirable service before it failed in this way, so that, under some conditions, such a gun might be very valuable.

The ball portion of the muzzle can be unscrewed, and so can the disc containing the socket into which it fits in the plate. This operation can be easily performed; a shutter being run up, which completely covers the opening from the enemy. It still appears possible, however, that a blow from a very heavy shot might distort and jam the screwed portion of the plate. Against ordinary siege guns such a gun working with all the speed due to non-recoil, and in an extraordinary measure of security, might effect much.

Two trials against armour took place, one to show the comparative effects of firing against chilled and soft hammered iron structures. As both were manufactured by Herr Krupp, the trial cannot be regarded

as a representative one of the system he opposes, and it would be a mistake to discuss it here.

The other was the firing of a 9·45-in. (24cm) gun, with a charge of 165·3 lbs., and a steel projectile weighing 348·3 lbs., at a target consisting of a front 12-in. wrought-iron plate, a wood layer of 2 ins., and a back wrought-iron plate of 8 ins. The plates were rolled at Dillingen. The projectile of each of two rounds fired passed completely through the entire 20 ins. of iron and grazed about 2000 mètres further up the

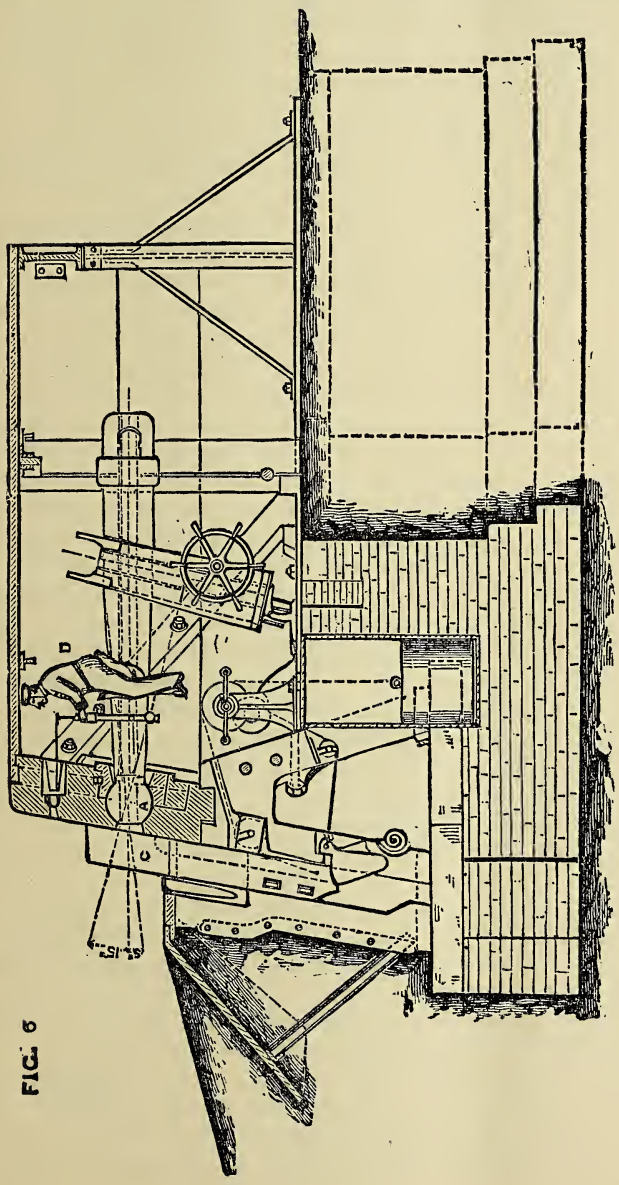


FIG. 6

FIG. 6.—Section of muzzle-pivoting gun in armoured salient fort. A, removable ball-piece, screwed on to muzzle of gun; B, socket disc screwed into shield; C, shutter; D, number laying gun from saddle-seat on chase.

range. The plates were indifferently rolled, and contained some phosphorus, it is said; but the penetration of the shot was, after making all allowance, extraordinary. They were scarcely deformed in appearance when recovered. The steel was excellent. They had ogival points, the heads being struck with a radius of two diameters. This complete and easy penetration of 20 ins. of iron by the projectile of a 9·45-in. gun is a striking feat. It may be instructive to analyse it. As a rule, we know the penetration which a projectile will effect, within very small limits, from its stored-up work and calibre. The length of the gun, 22·5 calibres, with its charge of prismatic powder and initial velocity of 1888 f.s. would naturally lead us to expect a striking velocity of something like that registered on this occasion, namely, 1876 ft., this, with the above projectile, would give 8499·7 ft. tons stored up-work and a penetration of 19·31-ins. of iron. Colonel Inglis estimates that when 7 ins. of iron is divided into two plates it loses 4 per cent. of the power of resistance it would possess if in a single plate. Probably 4 per cent. would be too large a deduction to make in the case of 20 ins. of iron being divided into two. Perhaps, however, we might consider that the 19·31-ins. of calculated penetration of the shot in a single plate would be just about sufficient to give bare penetration of 20 ins. in two plates. How are we to account for the margin of power which carried the projectiles 2000 mètres up the range; it is difficult to say what this amounted to. It is to be regretted that the device, adopted at Spezia, of placing velocity screens on the far side of the shield was not employed on this occasion, as we should then have known exactly what force was actually expended in penetrating the structure. There can be little doubt however that it was a good deal less than we have accounted for above. As there is no magic in these matters we ought to be able to trace the result to its cause. Two possible causes are apparent; one that which we have noticed already, inferiority in the plate, the other special excellence in the form or material of the shot. Now the plate exhibited signs of bad welding. I am inclined to think that the actual form of the hole made by the passage of the shot in itself argued this. The back of a plate exhibits the process of yielding under the blow of a shot in the following way:—At a certain stage in penetration the plate opens at the back in a small star or cross opposite to the shots point. The corners thus formed bend back as the shot proceeds, and, in a good plate, before the shot gets through, the corners are torn off along the dotted circular line, forming a rough hole of a diameter somewhat less than that of the projectile, which presses it out and and polishes it as it at length comes through. Now the Dillingen plate bent back and allowed the projectile to escape without tearing or shearing off these corners. This, I believe, argues bad welding, for as the plate approaches a laminated state the different layers acquire power to slide on each other and so accommodate themselves to the bend required to let the projectile pass through—just as it is easy to bend up the corner of a thin book remote from

the back, but very difficult to bend up the corner at the extremity of the back in a similar way. The fact that laminated armour resists the penetration of ogival shot less than solid plates is, I believe, due to this sliding of the layers on each other, and I should conclude that a plate that had yielded in this way was a badly rolled one. The actual tearing and separation of the plates further exhibited cinder between the layers.

Lastly, the steel of the projectile appeared to be excellent, and its sharp head, struck with a radius of 2 diameters, probably favoured penetration, and perhaps specially favoured it in the form in which it was effected. It will be interesting for those who have the opportunity of watching the trials with our new forms of projectile to notice whether there is a tendency in well welded plates to open out under the lateral thrust of the sharper joint, when it would tear off under the more direct pressure of the blunter ogival.

To sum up, the features which chiefly concern us in these extraordinary trials are :—

1st. The success of the breech-loading system. 2nd. The great results obtained as to power and accuracy of fire, due probably in a great measure to the use of prismatic powder. 3rd. The muzzle-pivoting and non-recoil systems.

Although these have been noticed in the short relation already given, one or two words may be useful to lead on to a discussion. First, it must not be supposed that equally good results have not been obtained, as to power, in this country when guns have been made in accordance with the conditions arrived at by our recent experiments, as may be seen from the following examples. *Two years ago* the new type Elswick 6-in. gun was fired with a charge of 33 lbs. and a projectile of 82 lbs., the initial velocity being 1902 ft. and total energy 2057 ft. tons; and in March last the same gun, with a charge of 37·5 lbs., discharged a projectile of 82 lbs. weight with a velocity of 2031 ft., having 2362 ft. tons total energy. With this may naturally be compared Krupp's 5·9-in. gun, fired at Meppen *last August*, with 33·1 lbs. charge, and with projectiles weighing 88·2 and 112·5 lbs., giving velocities of 1835·3 and 1668·7 ft., and total energy of 2060 and 2171 ft. tons, respectively. On one occasion (December 31st, 1878,) it is recorded in Krupp's printed tables as having fired a shot of 69 lbs. weight, with a charge of 37·5 lbs., with a velocity of 2135·8 ft., having 2183 ft. tons energy. In these comparisons the Elswick gun has slightly the advantage in actual effect and in priority.

I have recently learned that our government departments have for some time been making experiments with B.L. guns. There is now in course of manufacture, a field battery of B.L guns, and a 40-ton B.L. gun 26 calibres long. In such investigations we may well be stimulated by the example of Germany.

With the desire to elicit opinions on the points of greatest practical importance, I will conclude by expressing the conviction that the Meppen trials show that we are placed at a great disadvantage, under some circumstances, by our muzzle-loading system. Until recently the Italians and ourselves were the main supporters of muzzle-loading guns.

These guns were characterised also by being made of wrought-iron, which complicates the comparison I wish to make. Still the fact remained that England and Italy had muzzle-loading guns of 100 and 80 tons weight, and of a power with which no breech-loading ordnance could compare.

The Meppen trials have exhibited a gun which entirely surpasses the latter, and, for its weight, compares well with the former. Instead of dealing, then, with a theoretical gun existing only on paper, we have one in thoroughly good working order loading, and firing by hand with a rapidity, and shooting with a power and accuracy, beyond the achievements of our 80-ton gun up to the present time. This result is not due to a want of knowledge on our part, but to the impossibility of applying our knowledge to the case of the 80-ton gun.

With muzzle-loading guns on our present system, we have greater labour in loading, and, in the case of turrets, we have to commit ourselves to the length of our gun 3 or 4 years before we bring it into the service. To argue that breech-loaders should be at once adopted would be to commit the fault complained of above, but surely we have sufficient reason to give them a trial on a large scale. If breech-loaders have the advantages of ease and rapidity in working, of the possibility of changing their length without revolutionising the surrounding structure of the ship, and of affording greater cover, especially when on non-recoil carriages of any kind, they surely deserve a full trial even should it be at the cost of having both breech and muzzle-loading guns in our service.

At the conclusion of the paper the President invited discussion.

Lieut.-General Sir John Adye, K.C.B., Governor Royal Military Academy, and late Director of Artillery, said:—I am desirous of offering a few remarks on the important and interesting subject so well brought before us by Capt. Orde Browne, although time will not allow me to treat the subject adequately, or to do more than touch one or two salient points. We are much indebted to Captain Browne for bringing the subject forward at an Institution where it can be so appropriately discussed and with so much advantage to the service. Captain Browne has given us an account of the recent carefully conducted experiments in Germany of a 70-ton Krupp and other breech-loading guns, and has, as he says, called attention to their best results, and comparing them with those obtained from the 80-ton English and other guns, he infers that the superiority in velocity and power rests rather with the Germans, which he attributes mainly to their having better proportioned guns. Now, there is no doubt that within the last few years we, as well as others, have advanced considerably in scientific knowledge as regards rifled ordnance, and have ascertained that long guns with enlarged chambers and improved powder will give results considerably better than those achieved with guns designed even a very few years ago. Consequently, by taking a gun (say the 80-ton gun) which was designed six years ago, and then comparing it with ordnance of a more recent date, it almost naturally follows that the latter may show somewhat superior results; and we need not go to Meppen for experience of this kind. In a rapidly progressing science it is chiefly a matter of date of design. Captain Orde Browne himself is quite aware of this; for, having in one part of his lecture assumed that we are somewhat behind-hand, in another he cuts the ground away from his own argument by pointing out that as long as two years ago we had made experiments with muzzle-loading rifled guns which yielded better results than even those now recorded for the German ones of similar calibre. It is evident that whilst the science of artillery is and has been making such rapid progress, and whilst each series of experiments seems to produce more powerful and more accurate results, the only just way of measuring the qualities of guns made on different systems is to compare those designed and constructed at about the same time. Did time permit, I could give numerous proofs of this. Capt. Orde Browne, throughout his lecture, is evidently in favour of a breech-loading in preference to a muzzle-loading system of rifled ordnance, and is fully entitled to his opinion; and before touching upon this part of the subject I would first of all point out that a great deal of the mystery and of the heat which used to attach to this question has disappeared by the light of recent knowledge. Captain Andrew Noble (a scientific, clever officer, formerly in the Artillery and now a member of Sir W. Armstrong's firm—one who has had great experience, not only in using but in manufacturing guns) some time since made some remarks to me on this point which I believe correctly represent the case, and which are important. He says that, given certain data as to range, accuracy, velocity, and power, there is no difficulty in making guns, whether muzzle or breech-loading, which, being of the same calibre, shall produce practically identical results. As a manufacturer of ordnance, Capt. Noble's opinion carries great weight, and Messrs. Armstrong & Co. have demonstrated by practical manufacture that his statement is a correct one; and, indeed, Captain Orde Browne amply confirms it by showing that two years ago a muzzle-loading gun made by Sir W. Armstrong was tried at Shoeburyness and gave results rather exceeding those of breech-loading guns of similar calibre recently tried in Germany. Now, if we accept the above as a maxim, then the comparison

of breech and muzzle-loading guns becomes much simplified. If practically identical results as to range and power can be obtained from either system, we have only then to consider certain subsidiary matters which, though important, are not vital—namely, which system is the more convenient, which will give the greater rapidity of fire, and, again, which is the simplest, the cheapest, and the safest; and by safety I allude not only to the gun but to the men who work it. I wish it were possible for one to enlarge on these points, but time is limited. Captain Orde Browne asserts that the necessity for great length is fatal to muzzle-loaders; but he limits himself to the assertion, without proving it. The 38-ton gun is 19 ft. long, and nearly five years ago was tried in a contracted casemate at Shoeburyness—that is, in a casemate made for a much smaller gun. The firing was continued without intermission for two consecutive days, and it was found that, without mechanical appliances, the gun could be loaded and fired for a large number of rounds consecutively at the rate of one round in two minutes, and it was perfectly serviceable at the close. I shall be glad to know whether so prolonged and crucial a test has been carried out with a breech-loading gun of the same size and with equally good results, both as to efficiency and rapidity—prolonged rapidity of fire. As to firing large breech-loaders rapidly in contracted turrets, I have understood that the foul gas set free in opening the breech in prolonged firing might have a suffocating effect; nor am I at all convinced that the various processes of loading, opening, and carefully closing the breech in a dark, confined space would not cause confusion and loss of time; and it is, I think, evident that with an enemy's iron-clad steaming rapidly across your front, rapidity of fire, combined with safety, is of the utmost consequence. This is a very important point, and so far as we yet know the breech-loader may be slow, may entail anxieties and accidents in prolonged action, from which, at all events, the muzzle-loading guns are absolutely free. This important point of freedom from accident and safety to the men is one on which Captain Orde Browne is absolutely silent, and yet it has a great bearing on the subject. He has given us detailed accounts of the recent German experiments, but has made no allusion to the most serious one of all. It is said that the "unforeseen always happens," and it was so in this case. Whilst the officers of different nations were assembling at Meppen, a large Krupp gun (24^{cm}) not included in the programme, and not at the experimental ground, but on board the German training ship at Wilhelmshaven, suddenly burst, killing and wounding all the men but one. Surely this is a matter of importance; surely this requires explanation. Was it due to faulty metal, or faulty system, or what? He gives no details, and yet this is by no means a solitary instance of failure in breech-loading guns entailing loss of life, destruction of guns, and consequent destruction of confidence.* Captain Orde Browne says he is giving us the best results of Meppen, but we should like to know whether there are not other results fully deserving of careful consideration. But we may go further back, and from a study of the German field and siege guns can obtain some useful information. The German 9-pr. used in the war against France in 1870–1 was a gun firing a small charge (1 lb. 1 oz.) with a comparatively slow velocity, and yet we find that these guns failed in large numbers on service. The German official reports show that no less than 210 became disabled, chiefly from weak breech mechanism. Some of these, no doubt, were only temporarily *hors de combat*, but in an action this is a grave defect. The siege guns were similarly weak and defective. A distinguished infantry officer (Sir Lumley Graham) who was at

---

* Colonel Maitland saw a 28^{cm} Krupp gun which had burst, lying in the arsenal of Constantinople in 1877.

Versailles in 1871* with the Germans, stated that out of 70 B.L. 24-prs. no less than 36 had become unserviceable during 15 days' firing; and that had the French held out another week, the German siege batteries would have been silenced and their guns unfit for use, chiefly from weakness at the breech. A letter in the "Times" signed "Armed Science" amply confirmed these statements.† Herr Krupp himself, in 1878, in a letter to the "Times," said that after the war "the German Government remodelled the whole of its field and siege breech-loading artillery." Therefore it is apparent that up to 1871 the German field and siege guns, firing very small charges, became unserviceable in large numbers on active service; and a great power, after a most successful campaign, found itself compelled to remodel the whole of its field and siege artillery. We are told that all these defects have been remedied, but the recent improvements have not undergone the crucial test of war; and if guns of small calibre display such weakness with small charges, what may we expect with 70-ton guns in a prolonged and rapid action? At all events, we must, I think, suspend our judgment, and I would point out that from these grave defects of breech mechanism the muzzle-loading guns are absolutely free. There is one point in which I quite agree with Captain Orde Browne—namely, in the desirability of carrying on extended and crucial experiments with heavy breech-loading guns. Several of various calibres are, I understand, now under manufacture, and will soon be ready for trial as to power, safety, and rapidity of fire, &c. The problem stands in this way:—It seems admitted that guns made on either system will yield practically the same results as to range and general power; it therefore remains to be seen whether guns on a breech-loading system are equally safe in prolonged and rapid action, and in all the hurried incidents of service in dark, confined turrets, or between decks, and with partially trained men. So far as our own experience goes, and that of other powers also, there is reason to doubt whether they are so, or from their nature can be thoroughly relied on; but should these grave defects be overcome, and whilst safe should they prove more handy, more rapid in their fire, and more convenient for certain situations, the officers and men of the service will have no hesitation in adopting them. We are not wedded to any system, but are only anxious for the best weapons, and I have every confidence in the knowledge and skill of those who are in authority and responsible for these matters. Some years have passed since I had any real voice in these questions, but I cannot help still feeling an interest in them. The officers of the Royal Artillery have no personal interests to serve; they have no selfish motives in recommending one system more than another; they are not wedded to a muzzle or a breech-loading system. They are ready, as they have always been, to consider the best interests of the service. I would also add that we artillerymen recognise the fact that our guns have to be manned and fought by sea as well as by land; and we cordially recognise that in a great naval, military, and colonial power, and the necessity not only of unity of system, but of unity of feeling and support from the officers of the Royal Navy. I am sorry to have detained you so long, and yet I feel that I have only touched the fringe, as it were, of this great and difficult subject. (Applause.)

Major-General S. E. Gordon, C.B., R.A., said:—It appears to me that breech-loading is, in a manner, forced upon us by circumstances; we have

---

* See letter in "Times" of that date.

† Colonel Maitland reported that two Krupp field guns out of five were disabled in one battery in the Turkish war by the fire of the enemy, which injured the breech mechanism.

reached the extreme power of muzzle-loading guns, simply because we are unable further to increase their length. We have made them as long as they can be for use on board ships and in casemates. Guns of greater power are demanded, but we cannot arrive at greater power without greater length, and we all know that naval guns are limited in length by the small space available for recoil. The bore of this gun of Krupp's is 23 calibres in length, while our 38-ton gun is, I think, 18 calibres, and that of the 80-ton gun is about the same. There is no doubt that the power of the Krupp 71-ton gun is greater than that of the 80-ton gun at present, but if we could put on a few more feet at the muzzle of the latter, we could realise a far greater energy. Well, in order to increase the length of the gun, you must introduce a breech-loading arrangement. As to the question of the weakness of breech-loaders, we must remember that the gun which burst on board the German training ship was an old gun, and that it was the gun itself which gave way, and *not the breech-loading arrangement.* Therefore that occurrence affords no argument against breech-loading, although it may be an argument against making guns of steel. In 1868 the Ordnance Select Committee very strongly recommended a trial of breech-loading guns, but there were said to be very good reasons why the recommendation was not followed. We have got a great number of short guns, very good of their kind beyond doubt, but nevertheless unequal to longer B.L. guns which might have been produced of the same weight. We have two officers of high rank in the navy now present, and you may be glad to hear their views on the subject.

Admiral H. Boys, said:—The navy is fully in accord with the opinion of Sir John Adye, that it is desirable to test the merits of this question by experiments, and adopt the system best calculated to promote efficiency; and whether the result be breech-loading or muzzle-loading, the Admiralty and the War Office are in entire agreement in desiring only the system which is most perfect. As to the points at issue between muzzle and breech-loading guns, I suppose no one would have breech-loaders without very good reasons. The advantage would have to be considerable on their side, both in power and convenience, to justify their adoption, especially when we consider the vast change of stores throughout the services which the authorities would have to sanction if they introduced a new system. As to rapidity of fire, I may mention that three or four years ago one of our ships was prize-firing, steaming round a 12-ft. target, at a range varying from between 500 and 2000 yds., and that in the course of eight rounds, one gun—a muzzle-loader of 12-tons—would have hit a gun boat every time, and that the eight rounds were fired in 4½ minutes. No breech-loader could have done better than that. Then, as to the protection afforded to the gun's crew, I think the advantage is also on the side of the muzzle-loaders; for if you load at the breech on board ship, and your gun is run out, the port is open, but with a muzzle-loader the port can be closed and the rammer staff passed through a small hole in the port, thus giving the gunners more protection from small-arm fire. With reference to accuracy, we have the experiment at Shoeburyness with an 18-ton gun, which showed that out of five rounds three can hit a 10-ft. moving target at 2000 yds., which, I think, would be sufficiently accurate for the navy. However, notwithstanding all these considerations, we have to look at this question with modern lights, and under altered conditions. We have now different kinds of gunpowder, and different modes of combustion, and our newer experiences certainly point to increased length of gun as a necessity. But the ships cannot carry such long guns if they are to load at the muzzle; and as we have progressed hitherto, so we must progress still, and with the determination of having the best gun for the country and the services. (Applause).

Admiral HAMILTON, Director of Naval Ordnance, being invited by the President to speak, briefly said that Admiral Boys had well expressed the views of the navy on the question, and he had no more to add.

Major SLADEN, R.A., Professor of Artillery at the Royal Military Academy, said:—Under given conditions, there can be no doubt that there is safety in muzzle-loading guns which would be impossible in guns which open and close at the breech. Nevertheless, breech-loading is in the order of progress, for it facilitates an enlargement of the chamber to almost an indefinite extent, and it enables you to centre your shot with less trouble than in a muzzle-loader. It is also of advantage in the air-spacing of the cartridge, especially in field guns; for in the large guns the same thing can be accomplished by enlarging the chamber. Breech-closing guns, if they can be made so as to ensure safety—which Krupp has, I believe, so far succeeded in doing—are, on the whole, to be preferred. There will probably, however, be always more danger in a breech-loader than in a muzzle-loader, but we must submit to this if we would get more power. Admitting that muzzle-loaders are the very best for safety, we must, if we would go on, take the risk, as we always do in the army. I think that the enlargement of the chamber and the better centring of the shot are of very great importance in promoting good shooting, and I do not doubt that some arrangement will be adopted for preventing the escape of the powder gases at the breech. However, it is a very large question when it comes to a change of our *matériel*, and I think that we ought to be convinced that the improvement is at least 10 per cent. better than the existing system before we adopt it. Still, it is undoubtedly in the order of progress, and we must not stay behind; and, altogether, we may regard the case as one requiring very considerable and careful trial. We are much indebted to Captain Browne for introducing the subject, and this discussion cannot fail to have important results for the navy and the country. (Applause).

Major F. S. STONEY, R.A., Assistant Director of Artillery Studies, said:—Generally speaking, I come to nearly the same conclusions as Captain Orde Browne as to the advantages of breech-loading guns, but not because we have a model to follow in Germany. I notice also that Captain Browne has hauled down his flag; for this lecture, when first delivered at the United Service Institution, the other day, was entitled "Lessons from Meppen," and that now he has called it "The recent Experiments at Meppen." However, my contention is that it is not fair to institute a comparison between the work of a show gun, a show projectile, and a show powder, on a show occasion, in Germany, with the service gun, service projectile, and service powder which we have in constant use. Our 80-ton guns are immensely strong, and might, no doubt, be reduced to 70 tons without hazard, which would make the comparison rather more favourable. The whole question should be simply "Is it desirable to change from muzzle-loading to breech-loading?" I suppose we shall not be asked just yet to give up our wrought-iron for steel, and if the only argument is that we should try breech-loading with our own system of construction, I answer that we are doing so already—we are making the guns for the purpose at this moment. The question is not one which has hitherto escaped notice. In 1863, a very powerful Committee of Artillery, Engineer, and naval officers was appointed, and we spent £35,000 in two years on experiments between muzzle and breech-loaders. The biggest gun tried was a 70-pr., and the results of the experiments, as reported by the Committee, were that muzzle-loading guns could be fired with abundant ease and rapidity, and that guns satisfying all the conditions of safety could be made with steel barrels coiled round with wrought-iron, whereas guns entirely of steel were liable to burst explosively without the

slightest warning. From that time to the present, our wrought-iron guns have maintained their character for safety, while steel guns have always been attended with the risk of bursting. I do not lose sight of the enormous improvement which has of late been introduced into the manufacture of steel, and I have no doubt that in ten years' time steel, which is once and a half or twice as strong as wrought-iron, will be the material for our guns; all I would say for the present is that the time has not yet arrived for the wholesale manufacture of steel guns. More important than the improvement in the manufacture of steel, has been the improvement in gunpowder. About the time we made the experiments to which I have just referred, a discovery was made in America which was taken up by the Russians, and resulted in the prismatic powder used at Meppen. We, too, have carried out long and painstaking experiments, resulting in our large pebble powder, which, from its absence of sharp edges and corners, will stand transport better than the prismatic powder. The following fact proves its value:—When I was in the Royal Gun Factories, ten years ago, proving the first Woolwich Infant, we used 130 lbs. of the powder then in use, and we had a pressure on the gun of about 60 tons (and that was not a proof charge, which was 150 lbs.) The consequence was that when we came to examine the gun the next morning, we found a flaw in the tube, as you may remember; well, but so greatly has powder improved since then, that the 80-ton gun was fired the other day with 350 lbs. of our present service powder, and the pressure realised was only 22 tons, and we knew beforehand, from the modified powder employed, that we should get that result. From the great improvement, therefore, in the manufacture of gunpowder, resulting in so much greater mildness of its action, I should imagine that breech-loading appliances might be found sufficiently safe, simple, and durable for the purpose; and it is satisfactory to know that we are making experiments in that direction; but as for steel, I repeat that I do not think its time has yet arrived. But we all know how enthusiastic is Captain Browne, and how very energetically he rides his hobby. He is now astride of the Krupp gun, and probably, if he envies anybody, it is that Dutch officer who sat upon the gun while it was fired, at the risk of being blown to a thousand pieces. (Laughter and applause).

Colonel Le Fer Taylor, R.A., Secretary of the Institution, here asked permission to explain that he alone was responsible for the alteration in the title of the lecture, and that Captain Orde Browne had therefore had no hand in hauling down his flag.

Captain Orde Browne, in replying, said:—Sir John Adye has mentioned, as one objection to the Krupp gun, its cost. Now, I was very careful to keep steel out of the question, and as cost is especially connected with the material employed, I do not think the argument applies to the case; at all events, I question if a wrought-iron breech-loading gun would cost anything like so much as one of steel. I saw the working of the 38-ton gun at Shoeburyness, to which Sir John Adye refers, and it struck me that we had on that occasion got very near the limit of manual power. The No. 2 especially required to be a very powerful man. When I spoke of the 71-ton gun as easy to work by hand, I referred to the fact that it fired at the rate of a round in four or five minutes, while with the 80-ton gun nothing of the kind has ever been done. Indeed, the 80-ton gun has been much longer in existence, but I do not think that rapid firing has ever been *attempted*. I might, it is true, have taken the smaller Krupp gun, and compared it for rapidity with the 38-ton gun, which certainly works very well; but my argument rather applied to the rapidity of guns *exceeding a certain size*, when the difficulties increase. As to the bursting of a gun on board the German training ship, I do not see any ground for pleading that the bursting had anything to do with the breech arrangement, unless you may urge that with breech-loading the shot has less windage. I may quote, on the other

hand, the opinion of Captain Studer, who was over in this country recently, representing Herr Grüson, who is actually a rival of Krupps', to a certain extent. Captain Studer admitted to me that the gun was quite worn out, and ought not to have been fired at all. With regard to the German breech-loading field guns which failed in the Franco-German war, it is not in evidence that the failure was due to the breech-loading. At all events, they were not the Krupp guns dealt with in this paper, but of the Wahrendorf double-wedge system, and they were replaced by Krupp B.L. field guns. It is quite to be understood, therefore, that Herr Krupp would have no hesitation in referring to the fact. May I remind you that Krupp's guns are not the only guns which have burst lately—we have to-day been attending experiments on the accident to the "Thunderer" gun. The Krupp gun on board the training ship is not proved to have burst owing to the fact of its being a breech-loader. Now, it has been proved to-day, to all our satisfaction, that the "Thunderer" accident arose from double-loading. Could it by any means have been double-loaded if it had been a breech-loader? A highly-polished rammer may mislead you in loading a gun at the muzzle by hydraulic power; but is there one single officer here prepared to say that any man looking in at the breech of a breech-loading gun could possibly fail to see if there was already a charge and projectile in the bore? Major Stoney objects to the comparison between results obtained by our service projectiles and powder, with those obtained from German projectiles and powder. I would reply by asking what is the hardship in using our own service powder? Why the very suggestion that German powder gave Krupp an advantage, is an admission that we have, at all events, some "lesson to learn from Meppen." As to his remarks about steel guns, I repeat that I have tried to keep steel out of the question, but I believe you will find that there are steel guns which have fired 6000 rounds without suffering. And now, lastly, as to riding my hobby, I am anxious that it should be understood that I am no more the special advocate of Krupp than any person now present. My only object in repeating the statements contained in my paper here to-day, as I was requested to do, was to provoke a discussion which, I am happy to find, has been so valuable. (Applause).

General Smythe, the President, in concluding the proceedings, said:—I may say, in the name of all who are here, that we are very much obliged to Captain Orde Browne for his graphic and excellent paper. The question which it raises may well be characterised as of very great importance, and the interesting discussion to which it has led will not, I hope, be unattended with advantage. His weak point is on the military side; for, owing to the public opinion which governs this country, the Government cannot act always so promptly as desirable when it is requisite to produce a change. If, however, we find in existence so general a concurrence of opinion as seems to prevail in such a professional audience as this, it might be possible to convince public opinion, and carry out such improvements in the national *matériel* as experience may prove most essential to the nation's welfare. However that may be, the subject is too important to be forgotten or neglected. I never presided at a more interesting or valuable discussion, and, after what has taken place, I think we shall go away pretty unanimously of opinion in the main, although we may differ in minor particulars. Sir John Adye has fully, and I think fairly, taken the part of the muzzle-loading system, but after all, said very generously that he had no prejudice against breech-loading, and that he desired the fullest investigation in order that the right system should prevail. At one time an idea existed that discussions of this kind interfered with discipline, but how that could be it is impossible to conjecture. I have never heard the idea explained, and we may regard it as inexplicable. However, I may express, in your name, thanks to Captain Browne for his lecture, and say that, while we are sorry that he has left us, we see with satisfaction the continued application of his knowledge for the benefit

of the corps with which he was so long associated, showing that he has not forgotten us or ceased to take an interest in our work, and bring credit upon the corps to which he belonged. We remember that he was one of the observers selected to take charge of a party in the expedition for observing the transit of Venus, that his place was at one of the most important stations, and that his observations were not the least important nor the least valuable. I ask him to accept our thanks. (Applause).

TRANSLATOR'S PREFACE.

THE original of this article was translated by a Spanish Artillery Officer, and published in the excellent artillery journal of that country, the "*Memorial de Artillería*" for April and May, 1880.

The Introduction, which is written by the first translator, fully explains the purport of the article; the foot-notes also are by him, and principally draw attention to parallel cases in the late Civil War in Spain.

This was evidently written more especially for the benefit of artillery officers, but, it must, I think, be of general interest to all arms of the service, as a simply told story of some of the events of a war we do not know very much about, more particularly as regards such minor details as are here treated of.

J. C. DALTON.

Agra, N.W.P.,
June, 1880.

THE RUSSIAN FIELD ARTILLERY

IN THE

WAR OF 1877-78.

(*Translated from the "Memorial de Artillería."*)

BY

CAPT. J. C. DALTON, R.A.

Introduction.

Captain Politovski, in the Russian "Diary of Artillery," gives under this heading a series of articles, in which he describes the operations of his battery during this campaign.

These writings have an eminently practical character, for the author, instead of (as might be supposed from the title) treating of all the artillery operations, as a whole, limits himself to describing the incidents in which he was an actor or present as a witness, noting all the minutiæ of his battery or of those which were in his immediate neighbourhood on the field of battle, and deducing therefrom such lessons as he deemed the case required.

The merit of this publication is that principles and ideas of great utility, as regards details, can be gathered from it; and for this reason we have thought it suitable to give to our readers, leaving it in Captain Politovski's own words, and taking the liberty of ourselves making a few notes to draw attention to the many resemblances we discover in his writings between the Russian and Spanish artillery.

Part I.

Without entering into an extensive dissertation on the advantages and disadvantages of our (Russian) field guns, I wish to describe, in these lines, such events as may help us to form an opinion as to the services our artillery has rendered in certain cases, and also as to the services that it might have rendered.

Although I expound my personal opinion, I shall be very grateful if my brother officers, or any other person, will corroborate or challenge my remarks. I ask this in the interests of the artillery arm generally.

The events I mention are mostly from a note book which I kept up at odd times, sometimes during the battle, at others when it was over while all was yet fresh and vividly impressed on my mind. Regarding

everything from an artilleryman's point of view, I shall rapidly describe the actions in which I have taken part, either in command of a battery, half-battery, or division.

I will first mention the passage of the Danube, on 15th June, by the artillery.

I arrived at day-break at Zimnika with my battery (the 4th of the 9th Brigade), and, leaving it at this place, I proceeded to the ground where the fighting to secure the passage of the river was taking place. Three Russian 9-pr. batteries were in position on one side, and a Turkish battery on the opposite bank at Sistova, also a Turkish gun in the salient of a small fort on the northern side of the city. This piece was mounted *en barbette*, and firing slowly and accurately; all its projectiles fell within a small space, wounding two men, but without injuring any of the pontoons, which were ready for the crossing of the river. To counterbatter this Turkish gun, the three batteries above-mentioned fired 1500 rounds of common and shrapnel, at ranges between 2500 and 2950 yds., and another battery which was placed there for the same object fired 68 rounds.

It is so difficult to dismount a barbette gun at a range of 2700 yds. that it seems to me preferable not to attempt it, and to economise the expenditure of such a great number of projectiles. It may happen that the object is attained by a lucky shot* but no certainty can be relied on. One may harass the enemies gunners, but at a range of 2700 yds. shrapnel would be required, with a fuze adapted to that range. It is true that as the principal object was to occupy the enemy's artillery and prevent it from keeping up a fire on the troops crossing the river, the expenditure of ammunition was justifiable.

I leave the reader to judge of the responsibility attaching to our artillerymen, as regards the small effect of their guns, when people but little acquainted with artillery science remarked during the action that our 9-pr. guns were not powerful enough, and that four batteries were unable to keep up a fight with one gun of the enemy—soldiers, and even gunners, expressed such an opinion! At the same time that they were praising the accuracy of the Turkish gun, they were under-rating that of ours, in which we had the fullest confidence, and which, up till then, had fulfilled its object perfectly, when it was in the hands of people who understood it and appreciated its qualities.†

* On 4th February, 1875, we were at Puent la Reina after raising the siege that the Carlists had laid to Pampeluna; the latter constructed a battery in Santa Barbara de Manera, commanding the first named town; and, in order to counterbatter it, a field battery of the 3rd Regiment was placed on the hill of St. Gregory. After a few shots from the 10 centimetre guns, with which the battery was armed, notwithstanding the command of Santa Barbara, and its distance of 4300 yds., they silenced the enemy's fire, and afterwards our spies affirmed that a Carlist gun had been dismounted and many of the detachments wounded.

† This appears to afford an opportunity of relating what occurred on some occasions during the final period of our last civil war. In the lines of San Sebastian the Carlists had disposed in Arrat Sain, in a screen battery, 2 guns of 7 centimetre, with which they were perpetually harassing San Sebastian by shots, which appeared very accurate owing to the enormous target offered by the town; and it was absolutely necessary to attempt to dismount these pieces. What trouble the artillery officers had before being able to do what was necessary! one steel gun of 15 centimetre and four bronze of 10 centimetre placed at some 2000 yds. from the Carlist battery only succeeded in silencing the fire of one of the 7 centimetre guns and in damaging that of the other.

On the other hand, the Carlist of Antonenca, armed with two 9 centimetre guns was completely destroyed by the few shots fired by two 15 centimetre steel guns placed at 800 to 900 yds. from that battery.

Two other batteries that were placed on the left, on the island of Ada, were of great use. One of them swept the opposite bank with shrapnel, obliging the enemy's infantry to retire, and covering the regiment of Wolinski, which occupied it; the other battery did all in its power to attract the fire of the enemy's battery, and well dit it succeed. These batteries together only lost one killed, and he was an Infantry surgeon, who had come as a spectator. 25 per cent. of the Turkish projectiles penetrating into the wet bank, or falling into the water, never burst.

We will now speak of the attack on Jeni Saara. One column composed of five battalions of infantry of the regiments of Sjevski and Elencki, two batteries, Nos. 4 and 6 of the 9th Brigade, and half a squadron of Cossacks, all under the command of General Borejski, left Chanjkioj on the 17th July at noon, remained the night at Locha after marching 21½ miles, crossed the lesser Balkans on the 18th, and arrived at the celebrated Rosenthal (valley of the roses) which extends from the north towards the city of Jeni-Saara. Suspecting the presence of the enemy at this point, positions were taken up to engage him in an artillery combat, and to give time to the other two columns to join, one composed of four battalions of riflemen, which, under General Gourko, was to attack the enemy from the north-west, and another, under the Grand Duke Leuchtenberg, composed of cavalry, which should attack from the north. It was 8 a.m., the weather still and clear. Over the city a light mist of bluish cloud floated, rendering it barely possible to distinguish the edifices even with the assistance of glasses.

We were at about 5800 yds. from the city, drawn up in line of battle; both batteries had formed line according to orders. The troops continued advancing, without observing in the town the slightest sign of life, either all slept or else there was no enemy there. The city is in a valley, the surrounding ground and that which the battery had in front of it, is fairly level, the surface smooth, and the fields uncultivated. We suspected that the enemy might be in the railway station, which was hidden from view, on the other side of the city. After advancing five furlongs the batteries halted and a shell was fired at the city; the elevation corresponded to a range of 3500 yds., and, as was foreseen, the shell fell short. The enemy was not expecting us, neither had they perceived our march; a line of skirmishers preceded us, and all arrangements made for battle. The artillery would have done better to have surrounded the town more. We limbered up and continued the advance; great activity was noticed in the town; the batteries increased the pace. Now we saw for the first time the smoke of a gun from the enemy; the shell passed very high and fell near the *échelon* of ammunition carts. In our new position we elevated for 3500 yds., and laid the guns on the place from which the smoke had come; the shell burst at a house situated immediately behind the enemy's battery, which, after firing about five rounds, ceased firing and retired, thereby enabling us to bring our guns nearer to the town.

On the east of the city we perceived some 20 light horsemen, and at

the same moment the columns of smoke which were rising from that direction shewed us plainly that the Turks had established there a battery of four guns, the first rounds from which were directed at our reserves, and at the main body of the column, which was continuing to advance; at the third shot, the projectile fell into a battalion of the regiment of Elencki, wounding the Major and several men, the next in the midst of No. 4 battery, which opened fire and attracted the fire of the enemy to itself, which fire, it was plain, was directed in the same way as ours, viz., on the place from whence the smoke arose.

The enemy's projectiles passed high, and fell in rear of the battery without causing any damage, except one which fell between Nos. 3 and 4 guns, and another which mortally wounded a driver. Our shooting also was not much more accurate. Perhaps some may wish to attribute this to the state of mind of our men, but they behaved very well, considering that this was their "baptism of fire." All worked well, both intelligently and with coolness, as if at drill, and, with few exceptions, no troops could have shewn more presence of mind on their first coming under fire.

The small effect of our shooting may be attributed to local causes; the long grass and crops, which were not cut, offered a great obstacle to our observing the effects of our shots. The enemy's battery was placed in a depression of ground, as we found out afterwards, and could not be seen on the horizon; between it and us there was no conspicious object which could serve us as a guide by which to correct our elevations; and lastly, they were beyond the effective range of shrapnel. All our shell burst, but we knew that the damage done to the enemy was disproportionately small.

In the meantime we despatched a light attacking column, under Lieut.-Colonel Skugarevski, from the left wing against the enemy's battery close to the town, which was defended by a brisk musketry fire. No. 6 battery, situated on the left of No. 4, covered this advance, keeping up a fire on the town and its environs. This attacking column (*guerrilla*) came up on the left flank of the enemy's battery, which was obliged to limber up.

We now made an advance by batteries; No. 4 advanced about 350 yds., No. 6 about 700 yds., and No. 4 finally took up a position at the same distance off as this last. The attacking column dashed against the city, and after a struggle drove the Turks from it.

At 12 o'clock the batteries were informed that the Turks were concentrating in the railway station at the south side of the town. No. 4 limbered up and advanced at a smart trot obliquely to the left for about 950 yds., taking up a favourable position, from which we could distinguish the station, the buildings round it, and the Turkish troops; we opened fire at once at 1200 and 1300 yds. range.

It was quite easy to observe the effect of each shot, thanks to local circumstances, and we could judge which shot fell over or under, also the distance short and above plane that the shrapnel burst; hence we employed the latter projectile. At the third shot from our battery we observed smoke issuing from the station; probably the enormous stacks of wood collected there caught fire first, and this communicated

to the coal; and smoke shortly began to issue from the windows of the upper story. The enemy abandoned the post, and took refuge behind the wagons on the terreplein of the permanent way, from which they kept up a brisk fire.

Hundreds of bullets directed against the battery induced us to reply with shrapnel in the direction of the wagons. This excellent projectile did its duty satisfactorily; The change from common shell to shrapnel was effected almost instantaneously, without any hitch or mistakes in the length of fuze; it is true that the officers kept a careful watch. The sponge was barely into the bore before the No. 1 had laid the gun, not waiting for it to be loaded; in this manner the number who was preparing the fuze was not hurried, nor had the No. 1 to wait for him. This method is not according to regulation, but it certainly was effective, and the firing was kept up without interuption, and with great accuracy. In the meantime the flames had spread to all the buildings of the station.

The enemy exerted himself to place a battery on the right of the station; this attempt cost him the loss of two guns, the men and horses of which were put *hors de combat* by No. 6 battery.

I am impressed with the firm conviction that it is impossible to hold out against a battery firing shrapnel. The result of our first action exercised a beneficial influence over all the succeeding ones; the good effect of our guns made a favourable impression on the gunners, in whose faces one could read the confidence they possessed in their pieces, and in the certainty of a successful issue. Although we had been within effective range of the enemy's small-arms (1700 paces for the Peabody rifle), we had no one killed; the enemy's infantry did not understand taking advantage of the moment when the battery was changing its position. Keeping one shrapnel shell ready for each gun in case of emergency, we now returned to common shell, in order to demolish the wagons, in which it appeared to us the Turks were loading war material. Anyhow, it was deemed advisable to fire some wagons which obscured the camp from our view; for, whether the Turks had placed them there for that purpose, or whether they came there accidentally, they were prejudicial to us in either case. A few yards behind the wagons, the Turks were constructing a small redoubt for two ranks of infantry to fire from; although this was nearly completed, it was not quite so. The wagons obscured the redoubt, of whose existence we were ignorant; but afterwards we found out that the greater part of the common shell, which passed through the lines of wagons, had burst close to the redoubt, causing considerable losses.

After two series of rounds we ceased firing, or rather were obliged to do so, because a dense volume of smoke and flames, partly from the burning, and partly from the firing, prevented us from seeing what was going on in the station. In front, and on the right, we heard rapid musketry fire going on, interrupted from time to time by volleys. The attacking force of the left was approaching the station.

There is no more fatal moment for the artilleryman in action than when he hears such a remark as this—"It looks very much as if we were firing on our own troops." This unnerves all energy, and destroys

all the enthusiasm caused by the good shooting of the guns; a reaction sets in, and a feeling of disgust oppresses the heart.

It was an observation similar to this which caused us to cease firing. Great care is necessary, in certain cases, not to fall into such a mistake, the greatest attention must be paid to all the fluctuations of the contest. Sometimes the unfortunate remark is heard "It looks very much, &c.," when the shooting is at its best; the uncertainty is so great, that the best moments are sometimes flung away, and the result is that the uncertainty entails fatal consequences. The present case might easily have led to such.*

It would have been very convenient if the attacking force had communicated to the battery the results of our shooting; firstly, because the necessary correction in the shooting could have been easier determined; secondly, because they could have told us the best point to lay on; thirdly, because a misapprehension might have been avoided, which produced a bad impression both among the men of the batteries and of the attacking force.

Luckily, this time we were mistaken in believing that we were firing on our own troops; an aide-de-camp who arrived from the attacking force, told us the true position of friends and enemies, and indicated to us the point we should direct our fire on, in order to facilitate the infantry attack. We now knew what to do, and sent a continuous discharge of common shell against the wagons, and another of shrapnel just over them. Following on this we heard enthusiastic cheering from the 4th company of the regiment of Sjevski, and again from the whole of the 1st battalion; and soon after we saw our infantry charging with the bayonet towards the wagons.

The battery ceased firing, and trotted rapidly across the field, which was intersected with drains. In the fourth of these, which contained

---

* In mountain warfare it happens frequently enough that we cannot distinctly follow all the fluctuation of the battle, nor tell to a moment when the batteries covering the attack in a position should cease firing, and this may occur precisely when perhaps the fire of the protecting artillery is most absolutely essential. Among many other such cases I may mention the action of Velabieta on the 9th December, 1873. A battery of mountain artillery was supporting the advance of half a brigade of the advanced guard; it was necessary to carry the guns into a convenient position, and from thence they effectually shelled the wood, under cover of which the Carlists were; but when the fire from them appeared to us to be giving the best results, the horrible doubt entered our minds, and neither our excellent binoculars nor the keen eyes of the men could distinguish whether those we saw crossing the clearings in the wood, were Carlists retiring or our own troops pursuing, until at last we saw the gorgets (espaldas) glistening in the sunlight, and then knew that it was our brave Chasseurs whose canvas havresacks covered with oilcloth proved to us with certainty that they were there on the conquered ground. Afterwards we made out the Carlist groups, when sufficiently numerous, by their red caps.

In the action of Miravalles, we advanced our troops against an intrenchment in the mountain of Irurzun, supported by a mountain battery, until the proximity of our soldiers to the Carlists rendered it so difficult to distinguish the one side from the other, that we were obliged to cease firing, these last having acquired fresh stimulus either from seeing how exhausted our men were, or from the pause in the firing, or else inspired with the desire for a final effort; streaming out of the trenches, they precipitated themselves on the assailants, who wavered for one moment; but the battery observing this, fired off two guns, which were already loaded and laid, when the order was given to cease firing, and this contributing doubtless to give fresh vigour to the assailants, and discouraging the Carlists, the latter finally abandoned the position.

water, we placed fascines, but No. 3 wagon stuck in the ditch and delayed the five other guns from crossing, so I left the command of them to Captain Tischiuski, and galloped with three others to the railway, placed my battery on the line and opened fire, with shrapnel, on the retreating enemy. It may appear strange that I should use this projectile instead of common shell, but I could not help it, because No. 1 gun was already loaded with shrapnel from the first position, and after much firing it is very difficult to unload a projectile from the chamber. But it seems none the less strange to me, that in passing over the drains the fuze in the shell was not put in motion by such severe jolting; and, later on, I discovered that a loaded gun may be moved without any danger; thus, when passing the defile of Dalboka, of which anon, all the guns were loaded with shrapnel. Nos. 2 and 3 guns fired with common shell.

At the same time as the infantry was attacking the Turks, the light troops took them on the left flank, and the cavalry completed the rout of the enemy, which sought safety in a disorderly flight. Thus terminated this first action, which made a very favourable impression on the minds of all in the column.

Let me now make a few remarks on the field glasses used by the field artillery.

On a regulated scale, each section is supplied with field glasses; those used now, by Wadnej & Co., are not bad, but they are not repaired annually, as they are in the navy; this is absolutely indispensable to remedy the defects which the weather, and wear and tear naturally cause.

It would be better, in my opinion, if batteries were supplied with a good telescope, provided with a tripod, which could be carried in a gun carriage, limber, wagon, or wherever considered most suitable. The utility of this instrument will be proved later on, and I hope that this idea may be warmly supported in all artillery circles, wherein the inefficiency of our field glasses* is known.

The action of Jeni Saara, which commenced at 8.30 a.m., terminated, at 2 p.m., by the complete rout of the Turks. The city, station, redoubt, and wagons, we left five furlongs behind us. The column was allowed a halt—the batteries being placed near the river.

The column shortly received orders that within two hours it was to march for Karabunar, at which place an important concentration of the enemy's forces was taking place. These had delayed the Grand Duke Leuchtenberg in his march, and a collision was imminent.

In consequence of this warning, we cleaned our guns, which had become somewhat leaded, and we took stock of the ammunition. My battery had expended 10 common and 20 shrapnel a gun—in all 240 rounds. When the practice is good, the rate of firing becomes

---

* It is impossible to exaggerate the importance of good binoculars for the officers, and of first rate telescopes for the batteries; the former may be the property of the officer, as is the case with us, but it is necessary that they should be assisted in this expense by a proportionate grant of money, as should also be done in the case of books and plans, &c. As regards the telescope for a battery it should be a portion of its equipment.

insensibly more rapid. Considering the time and the circumstances, this was too heavy an expenditure of ammunition. We were completely isolated, and should have been very cautious in expending ammunition, as we did not know when or where we could have got more.

The proportion between common shell and shrapnel fired was 1 : 2,* and I am of opinion that that should be the regulation allowance for batteries, especially now that diaphragm-shrapnel and long burning time fuzes are employed; the satisfactory results abovementioned tend to corroborate this opinion.

Whilst the battery was halted, notwithstanding the fatigue I felt, I proceeded to inspect the battle field, not out of mere curiosity, but to notice the effect of our projectiles.

The station was reduced to ashes. Thousands of cartridge cases were strewed about as if a whole brigade of mitrailleurs had been in action there. Our projectiles had transformed the wagons into wrecks, the fire had communicated to those nearest to the station, in which there must have been great quantities of ammunition, judging from the repeated explosions which were still taking place.

I will not attempt to describe the impression produced upon me by the dead and wounded stretched out in this horrible area of death and pain; it will ever haunt my memory.†

The greater number of those killed and wounded by artillery were behind the wagons or in the redoubt; they were easily recognisable by the nature of their wounds. In the position finally occupied by the Turkish artillery there were several dead horses and bullocks, and part of an ass.

Between the wagons and the redoubt there was a fragment of rail a foot long; the fracture appeared old, and we could not possibly suppose that a shell from one of our guns, even under the most favourable circumstances, could break and tear off such a fragment of iron; but the general extent of desolation and destruction which surrounded us produced such an effect on some infantry soldiers, that they did not hesitate to affirm that the fragment of rail had been severed by one of our shells, and I did not attempt to disabuse them. It is often amusing and, moreover, useful, to overhear the simple and pithy descriptions by the soldiers, of the behaviour of the troops that have taken part in an action, or their criticisms on the orders of their superiors. After awhile all their stories get distorted, but, in the first moments, impressed with the recent events, and animated by feeling, there is a great attraction in them, and, in the main, there is, underlying all, a

---

* The regulated proportion in our service is 3:2 in heavy and 1:1 for light pieces. All artilleries are systematically increasing the number of their shrapnel, the value of which is greatly due to the perfection attained in the manufacture and employment of these projectiles, and also to the adoption of the "double gallery" fuzes.

† With infinite pain, one is reminded, by this sanguinary episode, of the disastrous affair of San Pedro Abanto, the 27th March, 1874. Our civil discords produced on that day a most horrible hecatomb; hundreds of dead were extended on the road leading from Carreras to the village of Murrieta. At midnight a reconnaissance was made, to place an advanced battery over Abanto, and the silence of the night, and of death, left in our minds a lasting effect that time can never efface.

very strong under-current of truth. Whilst I was examining the wagons, I could not repress a smile as I heard the infantry soldiers, who were close to me, eulogizing the artillery most enthusiastically.

Up to that day we had only been an impediment to the infantry. It is, no doubt, disagreeable to see the infantry soldier, encumbered as he is with his own equipment, obliged to afford assistance to the horses when they got into difficulties in bad ground. But, "it can't be helped"; the guns must march; every soldier knew this, and assisted with superhuman strength, trusting in advance to the future assistance of the artillery.

This confidence was well justified by the event.*

Part II.

At half-past four in the afternoon the column, evacuating Jeni Saara, began its march, taking the main road in a westerly direction, and at nine o'clock it came in sight of the village of Karabunar, which was in flames. As we approached the village the flames became extinguished, and we encamped in the neighbourhood, in an unreaped field of wheat. At four a.m. on the 19th, we resumed our march on the same road, which, after some kilomètres, became very steep.

It will be advantageous here to say a few words about the general appearance of the country. The road that leads from Karabunar to Eski Saara runs in a direction from E. to W. Two or three kilomètres on the north, and parallel to it, runs the crest of the lesser Balkan, whose southern face is covered with woods, vines, and orchards. Between the road and the foot of the mountain there are stretches of wheat fields, maize, brushwood, and vines. At the left of the road is the Valley of Maritza, rather narrow, and cultivated generally, with here and there copses of trees and thickets. A few kilomètres on we came to a fairly thick wood, commencing at the same road, and extending in a southerly direction, and afterwards turning and extending along the right of the road. Between the wood and the mountain were fields of maize and vines, and some isolated trees. The general incline of the road was to the south. The object of the above-mentioned halt was to wait for the 4th Brigade of Rifles to come up (they had left Jeni Saara in the morning), and when they joined us we pursued our course until we heard, at eight o'clock, the sound of a cannonade in our front.

---

* The whole of this narrative is precisely analagous to what might be written of our last campaign. The Plasencia gun and that of 10 centimetre were our triumph, they were the natural friends of the valiant and enduring infantrymen. Not a man shirked yoking himself to the traces or the wheels, in order to get over a bad place; and now artillery is no longer considered *impedimenta*, and shares equally with cavalry and infantry the glories of the battle field.

The wood was five or six kilos. from us, and on its N.E. boundary we perceived the smoke of four of the enemy's guns, which were engaged with two of our horse artillery batteries at a range of 2000 yds. The shell burst high, and did not reach the Turkish battery. Our guns soon ceased firing. The men of my battery took a lively interest in this action, and showed their sympathy with the horse artillery at every round they fired.

Our men could not understand why the firing had ceased, and made various conjectures; but at the end of five minutes we again saw the smoke of the Russian guns, and this time the shell burst much more accurately. Punctually at eight o'clock our column passed from order of march to that of battle. The battery proceeded in a S.W. direction as far as a small copse, at about 2000 yds. from the enemy's battery; this we had to cross, and were to occupy a position fronting the large wood, from the margin of which came the smoke of the enemy's guns. To tell the truth, we could not understand why we had to cross the small copse, and when the battery was moving at a walk in the direction ordered, an officer coming in a contrary direction told us that we could not cross the wood, and also that on the other side of it we should not find any good position. After this it was useless to attempt it, and we moved round to the left, and came into position some 1000 yds. in front of the big wood, in a reaped wheat field, the ground being covered with the sheaves. The ground around this field was covered with maize, &c., we were therefore hidden from view, and could just see the margin of the wood we wanted to fire at over the maize. The enemy either did not notice our movements, or else the nature of the ground did not permit him to molest us, for up till then he had not fired a single round at us.

After the battery had got into the position above-named, we soon saw that the field of sight was very limited. We could shell the edge of the wood where the enemy's battery was, but at the distance of 2000 yds., in such unlevel ground, it would have been difficult to observe the effect of our shell. We therefore moved about 100 yds. obliquely to our left, to a better position, where we unlimbered and opened fire with common shell.

The enemy replied. His shells were very wide, all falling on our right. We could not well tell the effect of ours, although we had a larger bursting charge.

We now observed some of the enemy's cavalry on our left. We had seen nothing of our infantry escort, and a musketry fire was directed at our front. The enemy's cavalry was plainly moving towards our left flank. After we had fired a few shells, the officer commanding the 2nd centre battery gave the word "case shot." The cavalry moved rapidly still more to the left, and finally formed groups, and took cover in the wood.

This sudden appearance of cavalry destroyed the tranquillity of mind that up to then had distinguished our men. Expecting at each moment a fresh attack from another direction, we could not devote ourselves to the enemy's battery; more especially as a musketry fire played upon us without our being able to see from whence it came.

We rapidly perceived that our position was a very bad one. The fire of the infantry, the threatening of the cavalry, and the gradual moving of the Turkish artillery from left to right, showed us that we formed the objective point of the enemy. To prepare for a new attack from the cavalry we changed front by throwing back the left. Colonel Wulfert now arrived, sent by General Gourko, who perceived that the battery was without an escort. The Colonel examined the position and gave orders to ensure the safety of the battery, which limbered-up and advanced at a trot to a new position, in which we had the advantage of having all the edge of the big wood within shrapnel range. On the right, in the direction of the left Turkish gun, there was a well, and behind it a small cleared space. In this direction we had a clear field of sight, but on the right and left the ground was so covered that it was quite possible for the enemy to advance to within 150 paces of us and be hidden from our sight. General Gourko sent an aide-de-camp with an order for us to open fire on a column of infantry hurrying past the corner of the wood.

As I have mentioned, from the battery we could only see the top of the wood, and it was necessary to advance, but we chanced to come on a sunken road. This communicated with the high road, and crossing our right wing led towards the right wing of the Turks; it was a road made by the rains and torrents—a fissure, with scarped walls, 6 ft. wide and 3½ ft. deep.

The battery opened fire in the direction of the margin of the wood, which was very easy from our position, but we did not know the result of our firing. Two more guns then reinforced the Turkish battery and opened on us, making up the number of the enemy's guns to eight. The infantry fire against us increased in intensity, and, to avoid useless loss of life, we dismounted the drivers.

No. 6 battery, which had remained in reserve, took up a position about 1100 to 1200 yds. on our left, and its front formed a right angle, or thereabouts, with ours. A shrapnel shell burst high above our heads, and the fragments passed over us harmlessly; not so, however, the infantry fire, which wounded or killed one of our men every minute. We decreased the elevation and bored the fuzes shorter.

At about 25 paces on our left there suddenly appeared some men of the regiment Sjevski, as if they had sprung out of the ground; we did not know whether they were part of a small attacking force, or whether they had arrived as escort to the guns. On our right flank a line of skirmishers of the regiment Elencki was retreating. Suddenly, the artificer of No. 4 gun, who was on horseback, shouted out "the Turks!" "the Turks!" "there they are!" and pointed with his finger to a maize field. There was no doubt of it; at 300 paces from the battery, among the stalks of the maize, we clearly distinguished the red fez—the moment was critical.

Once more the order went forth, "case shot," and hardly were we loaded when the Turks discharged a volley right in our faces, and we received a shower of bullets.

"No. 5 gun," "No. 1," "No. 8,"—thus, at the same time, were heard the voices of the three Nos. 1 of these guns, and the reports of the three

guns resounded as one; one after another the other guns belched forth case shot against the Turks; we loaded anew; every effort was made; each gunner tried to vie with his comrade, but, even then, the period between each shot appeared an eternity.

The noise of the bullets which whistled past our ears and buried themselves in the ground, the noise of the men, horses, and guns, the cries of the wounded—to which no one could attend—interrupted by the laconical word of command "fire," the bursting of the shrapnel over our heads, the smoke from the guns, and the countenances of our men blackened with gunpowder, and bathed in perspiration—all these condensed into a few minutes will for ever remain before my eyes as an emblem of war.

This was the final and desperate effort that the Turks made against our centre; the most vigorous and energetic that took place in this action, according to official accounts.

Above the battery there was a cloud of smoke; the case shot was becoming exhausted. Danger close at hand. At the limbers might be seen another lamentable picture: that of horses wounded by the enemy's fire. Worthy death for these beautiful and noble animals, who, without a cry or complaint, bid farewell to the man with a look of resignation and affection!

From time to time are heard the exclamations of a driver trying to hold in his horses, and who is at last obliged to cut the traces and burst the buckles in order to let the animals free; disorder gains ground; a driver struggles in vain to extricate himself from a horse which has fallen wounded. Everywhere are to be heard voices and shouting; this man is wounded, that man the same; "the spare horses"—"where are they?" "Sir, all the case shot are finished"!

Much *sangfroid* and great presence of mind are necessary in order to keep one's head amidst such chaos and disorder, and to keep one's face unmoved, and infuse tranquillity and confidence. In a word, the battery had lost *morale*; that last exclamation was like a death-blow, and the probability of the loss of our guns stared us all in the face.

The left half-battery received the order to retire 100 yds., and open fire with shrapnel, without attempting to refit in any way, and to fire as rapidly as possible, with the fuze bored at the first hole.*

The right half-battery loaded with their last rounds of case, and awaited with bated breath the imminent assault of the Turks.

In this critical moment the Chasseurs re-appeared on the right flank of the battery, and fell on the left of the Turks; at the second charge of the 13th and 14th battalions of the 4th Brigade of Chasseurs the battery was saved, and the fate of the battle decided.

Three guns of the right half-battery joined the four of the left half, leaving the fourth gun with only two horses, one of which was wounded; an officer, whose horse had been wounded, remained at the gun with a few men. The infantry fire became less and less, and no Turk was to be seen in the maize.

* They did not seem to know of firing shrapnel reversed, as case, without any fuze or plug. What time might thus have been saved, and the moral power of the battery maintained in the eyes of the men.—J. C. D.

We heard a general cheer, and ceased firing, for fear of injuring our own troops. An aide-de-camp arrived: "What's the matter, why is this battery retiring?" Then, directly after, another "Forward—a general advance of the whole line." "Permit me, Captain, to go on in front, and reconnoitre the ground; the battery cannot advance here on account of this road," said one of the officers; "Very well, go."

At this moment his horse was wounded, and the rider fell: "Are you hurt?" "No." An artificer came up and offered his horse, and the officer mounted and galloped off. We now arranged the battery by equalizing the teams to four horses a gun, as far as we could. The officer returned and made us signs with his hand—"Left incline—trot."

We had to incline some 100 yds. to the left, to pass the sunken road. We did not want to stop to fire, because the Turks were in full retreat across the wood, throwing away in their flight great quantities of bread and other provisions, which, unfortunately, we could not wait to pick up.

Firing in the front, and on the flanks, had almost entirely ceased. On arriving at the large wood, we followed the edge of it, which we had previously been firing at; once in the high road, we took the direction of Dzuranli, towards the west.

When following the edge of the wood, we were able to see that, notwithstanding the unfavourable conditions under which we laboured, our shrapnel had done its work, judging from the dead bodies of men and horses which we saw there, and the quantity of broken trees and branches strewed about. Near Dzuranli the battery took up another position, expecting that the action would be renewed. The enemy were about two miles from us, and we perceived them on the other side of Eski-Saara, by the great columns of dust they raised.

It is only just to the battery to say that, notwithstanding the sudden appearance of the Turks, and of the deadly fire that decimated us, it maintained discipline, and remained steady to the last moment, and, thanks to this, it was able to defy the danger. This circumstance is not so insignificant that we should pass it by in silence. In this action the battery had 13 per cent. of men and 25 per cent. of horses placed "*hors de combat.*"

It is worthy of remark that at a period when, in consequence of the improvements in fire-arms, artillery is being obliged to modify its system of fighting, in order to operate at much longer ranges, and when many artillerists are considering case shot as being hardly worth discussion, a battery of 4-prs., for some minutes, at 200 to 300 paces, resisted the enemy's infantry, and was able to maintain itself and save its guns, expending all its case shot and suffering comparatively small losses.

This case cannot be considered an exceptional one, for, in this war, it was constantly happening—above all when acting on the defensive. I do not know whether the ground had been reconnoitred in the morning, or not, although there had been plenty of time to do so; but later on I found an opportunity to look over the battle field, and was convinced at the same time that there were many much better

positions than that which we had occupied; when the plan of the battle is unknown, it is difficult to select the most advantageous position.

Independently of all other conditions for a good position, it is most necessary that there should be a good clear field of sight in front of the battery. Laying on the smoke of the enemy's guns is only admissible as a *pis-aller*, and when the battery is obliged to remain in a fixed position; but, on the offensive, it seems to me that it is not necessary that a battery should be restricted to any fixed position in the order of battle; it should adapt itself to the ground in successive phases of the action. It is an error to send a battery (to make the enemy deploy his forces) to a position from which it can only see smoke to lay on, and cannot judge of the effects of its shooting.

A battery ought not to be exposed to attack from a line of skirmishers which, owing to nature of the ground, can approach unseen to within 200 or 300 paces, and make a dash at it.

Artillery should avoid opening fire at too long ranges, but only on rare occasions is it prudent to approach to within 400 paces of the enemy. The cases in which a battery should take position nearer to or further off, are so numerous and varied that it would be impossible to classify them.*

I. Dragomiroff says that there are no better advisers than time and circumstances.

To make a few remarks on the important question of escorts, I may be permitted to quote from the words of the Archduke John:—

"If the enemy advances on the battery, the latter will use grape. If, however, the battery has to retire to avoid falling into the enemy's hands, then the escort must do its duty with energy and devotion, covering the movement of limbering-up and retiring with a rapid fire; or, if needs be, they must cross bayonets with the enemy without regarding their numbers, and resist so long as the battery is within the effective range of musketry, or until it has gained cover from the nature of the ground. If the escort is completely sacrificed, it will have fulfilled its duty. In retreat, the escort must not be in front of the battery, but on a flank, selecting the more exposed one."

According to my opinion, from the moment that a battery is separated from its place in the column to take position in order of battle, it should have an escort, which should be under the orders of the battery commander until the end of the fight, without reference to the seniority or rank of the leader of the escort. It is necessary for the battery commander to know the strength of the escort, and who commands it. During the action no one should have the right to remove it, and all orders to reinforce or reduce it should emanate from the general of the division to which the battery belongs.

The reader must not think that I am paying a tribute of gratitude to case shot, for the good service it did us in times of danger; on the contrary, I have always believed, and still believe, that case shot should not be required for field artillery. We took to it out of necessity.

---

* It would appear to be admitted now, that, on the defensive, the artillery should accompany the infantry in the assault of a position to as far as about 800 yds. from the enemy.

We know that the smallest graduation of the time fuze for our shrapnel shell—viz., $\frac{7}{8}$-secs., corresponds to a range of 300 yds.; this was diminished to $\frac{4}{8}$-secs., and with it the moral and material effect of the shrapnel is much greater than that of case shot, as I personally found out in a critical moment during the battle of Elena.

Before ending my remarks I would wish to mention the sword, which, in my opinion, should be done away with. In the actions I have already mentioned, and in those which followed, I became fully persuaded of its uselessness. It is an unnecessary weight to carry, is troublesome to the man, often frightens the horse, and spoils the clothes. Can any gunner tell me that he, or any other, has ever had occasion to make use of his sword? And there were certainly many occasions in this campaign when the enemy suddenly surrounded the battery, and was near enough for a hand to hand fight.

In each case it would have been quite sufficient to have had a short cutlass (Kortiks), as they have in the navy, which has the double advantage of serving in the bivouac as a knife, and in the battle as a weapon. The sword with a metal scabbard has many disadvantages; it loses its edge, the scabbard rusts and gets dented, the buckles and slings of the belt get broken, it interferes with the mounted man when he is riding, annoys the horse, makes a noise, &c., &c.*

The battle of Dzuranli ended at 3 p.m. After the column had occupied the ground abandoned by the Turks, it concentrated across the wood, and awaited new orders. The battery formed "column of route," and remained on the high road.

Overcome with intense thirst, I directed my steps to a well, round which some soldiers were collected, and out of which they were trying to get water by means of their canteens. The battery was only at about 70 yds. from this well; so I called an artificer and ordered him to send two men with camp kettles, to get water for the men. On examining the place, I found that the well was the same by which we had corrected our elevations when firing against the enemy's infantry. The well was in the centre of the position, although, from the battery it had appeared to us as being slightly to the right; we had therefore not been occupying a central position, but one rather to the left; No. 6 battery had been still further to the left; it had, however, a clearer field of sight than we had.

Around the well were a few dead bodies of Russian soldiers, and 300 yds. further on, in the direction of the wood, heaps of dead Turks. On returning to the battery, I saw a line of wheat sheaves piled up crossways, with a trench in front, the earth from which was thrown into the sheaves. It was quite apparent that the Turks had been waiting in that position for us, and this was confirmed by there being look-out places in the trees, in one of which, a Turk was suspended

---

* The author seems to forget what I take to be the greatest defect of the sword—viz., that when serving the gun it is constantly getting between the legs, and in the wheels and brackets of trail. In England the drivers have no weapon, it being considered that in case of close quarters they have enough to do to manage their horses. With us the mounted men only have swords, and the others a short sword-bayonet.

head downwards. On crossing the wood we saw a species of lunette of weak profile, but sufficiently thick to protect against musketry fire; in its limited space there was a great number of corpses.

From our position, the wood intervening, we had not been able to see this lunette, and, therefore, those in it who had been killed by artillery fire, owed their deaths to our battery of horse artillery, which had cannonaded the Turks left, from our right wing.

Having examined the position rapidly in the short time allowed, I rejoined the battery, which was entering Dzuranli, the rendezvous for all the regiments that had been pursuing the enemy. The Chasseurs alone had not yet returned; the infantry were distributed about the narrow winding streets of the town; the cavalry were behind the town, facing a mountain which was held by the enemy; and to our two batteries, a small space was told off, in which we formed in column of route. We called the roll, and took an inventory of our ammunition, and found that we (No. 4 battery) had expended 180 common shell, 300 shrapnel, and 30 case shot.

In addition to the losses previously mentioned, we found that there were 3 men and 10 horses slightly wounded. The *materiel* was in a comparatively good state; some rifle bullets had penetrated the sides of the limber boxes, and had also damaged several spokes and felloes of the wheels. In one gun, we noticed a great escape of gas, owing to damage to the breech-closing arrangement; later on, it was necessary to replace this piece.

No. 3 gun, and two ammunition wagons, had not as yet joined us, and caused me some anxiety; I therefore sent to the commander of the train, with 12 pairs of horses and two artificers to bring off these carriages.

There was, however, no need for alarm, as an under officer (Feldwebel) had been left with the gun, on whose ability and judgment I could safely rely. The officer was justified in not remaining with the gun during the general advance, for, without horses, nothing could have been done, and the two wagons were nearly empty. In the meantime, we moved to a position fronting the city of Eski-Saara, which was burning; the enemy was on the top of a neighbouring hill, and was, doubtless, occupied in fortifying his position. As we did not know whether we should continue the advance, open fire on the enemy, or bivouac, I prepared for any contingency, and ordered the guns to be cleaned. To my great astonishment, I discovered that two of them were loaded with shrapnel; I ordered them to be unloaded, and took the cartridges out, and then tried to extract the shrapnel, but in vain. After all the firing, especially with the case shot, during which time the sponge had not been used, the bore had got so foul, that all efforts to extract the projectile were in vain. We could not fire them off; moreover, we were forced to economize our ammunition, especially shrapnel, which we most required. Having received orders to advance towards the N.E., we supposed it was in order to bivouac; I therefore resolved to leave the guns loaded, and make all right when we encamped. We had acquired great confidence in the shrapnel, and had not had any accidents in manipulating it. Moreover we had

already, once or twice, gone over a long distance, with guns loaded with shrapnel, and I am convinced, that in case of need, one might travel the gun loaded with this projectile securely, without any danger, for long distances.

The projectile being securely placed, it would need a very heavy blow, such as, for example, tumbling over a precipice, to break the safety-pin; but a series of continuous blows, might cause it to yield by degrees, and finally liberate the striker.

As soon as we had available time, we extracted the projectile, by pouring hot water down the bore, and leaving it there for about five minutes; the extractor was then introduced by the muzzle, and the fuze extracted.

The defile of Dalboka is very tortuous, in some places moderately wide, but in others narrower than the track of our carriages. I had to take precautions that these should not get upset, and have them steadied by men with ropes, who walked with difficulty on the steep sides of the ravine. This was a dangerous operation: one false step, and the whole lot, men, horses, and carriages, would have come to grief. We only used the wheel horses, unhooking the others, and having men pulling on drag-ropes, and manning the wheels, &c.; we had occasionally to unlimber, and lift gun and limber separately. To each gun, a company of infantry was told off, of which one half acted as escort, whilst the other half were on fatigue, and assisted the gunners, the two relieving each other frequently. We began the ascent at 4.30 in the morning, arrived at the opening of the Pass at 5 in the afternoon, and by 9 at night were posted in the neighbourhood of Balabandzi, that is to say, we occupied 12½ hours in the ascent, and 4 in the descent. Although the latter was longer, it was much less steep, and therefore, notwithstanding the tremendous efforts made, the ascent took us much longer than the descent; we had 10 or 12 men on each carriage, to act as a drag. We trotted when we could, in order not to delay the troops in rear, and also to get out of the defile as quickly as we could, as the enemy, if he had attacked us there, might have done us great harm.

THE QUESTION OF THE AMMUNITION EQUIPMENT OF ARTILLERY IN THE FIELD.

BY

MAJOR S. J. NICHOLSON.

The "Notes on the Ammunition Equipment of Artillery in the Field," published in the last December number of the R.A.I. Papers, open so large and vital a question, and the conclusions drawn in it are so sweeping and so diametrically opposed to our present system (with which it may safely be said a majority of officers are quite satisfied), that it may be permitted to urge some arguments in favour of the existing state of affairs.

The Notes suggest that the authorities, who settled the proportion of projectiles carried, arrived at their conclusions from having "overlooked or insufficiently considered the conditions of service in the field." Might it not, however, be fair to suppose that to this most important factor they gave its full value, and that the system they pursued was very much as follows, viz.:—Having taken the results of carefully conducted and minutely recorded experiments to show what amount and what nature of work the various projectiles were capable of doing under favourable circumstances, they then considered thoroughly how much of such effect might fairly be expected under the strain of service; and these two preliminary enquiries being finished they settled, from a consideration of the frequency of the occurrence of the various requirements of field artillery, what proportions of different projectiles should be carried.

The object of the following remarks is to suggest that such a supposition is not unwarranted, and, in addition, that the results arrived at are satisfactory.

For the sake of clearness the description of characteristics of the various projectiles, and the recommendations urged in the notes, are here shortly arranged and epitomized.

A. Case is "for close quarters," and as guns may have "to defend their immediate front," an increase from the present four rounds to eight is recommended.

B. Common shell is for "rough and heavy work," and, as a "rough and ready ammunition is always more reliable in battle," an increase from 32 to 108 rounds is suggested.

C. Shrapnel appears only "to be useful against an enemy in the open, or comparatively in the open, when time fuzes can be adapted to the range;" "it is useless against heavy cover;" "time fuzes are dangerous when firing over the heads * * * or across the front of our own people;" "the adaptation of time fuzes is unfavourable when fire is passing through or over a battery;" they cannot be judged from * * * anywhere near the guns," and "officers cannot be out in the position of range parties;" shrapnel is, in fine, a "delicate ammunition."

The only conclusion drawn in its favour is that its "fire when effective is more powerful than the effective fire of common shell."

From these premisses it is argued that the proportion should be reduced from 112 to 32 rounds, and it is suggested that the only question which would then be left for solution would be whether it might not be judicious to reduce it still further.

It may be as well to consider a little more closely the nature and performances of the various projectiles, in order to see to what extent it is possible to agree with these statements and deductions.

(*a*) Case is a despised projectile because an opportunity or necessity for its use but seldom occurs; if its great value, however, in grave emergencies were remembered it would hardly be so. Little or nothing has been done of late years to increase its efficiency, and in consequence many a brilliant chance may be lost, and many a reverse experienced, from the fact of its present very limited effective range. If steps were taken to increase this limit, such a proportion as that suggested in the Notes might be advisable; in default of this being done, the expediency of doubling the number must remain an open question.

(*b*) With respect to Common Shell, it may be as well to describe what its actual nature is, and from this to deduce what may be expected of it. The shells, from the fact that their structure is very variable in strength and tenacity, and that the action of their bursting charge varies greatly in intensity, break up into a few irregularly-shaped pieces, differing in number, form, and power in almost every instance. The path of the splinters, after the bursting of the shell, is compounded of the velocity of the shell at the instant of opening; of the radial force of the bursting charge; and of the centrifugal force due to the rotation of the shell. The two latter being very large compared to the first, and the force of the bursting charge being very uncertain, a wide and very irregular dispersion is the consequence; in addition to this, both the form and the motion of the splinters being most unsuitable for the retention of velocity, they soon lose their power.

Shells of such characteristics as these can hardly be of any use for the ordinary work of field artillery. When burst in an object which offers resistance, or tends to concentrate their dispersive effect, they are, of course, useful; when, however, they are burst in the open against objects in themselves dispersed, and which can only suffer from a large number of projectiles covering a considerable area thickly, they must surely be wanting in effect.

Undoubtedly, both the Dartmoor and Okehampton committees, composed as they were of officers of every shade of thought in the regiment, arrived at a very curious consent on this subject, both individually and collectively. The first recommended the almost entire omission of common shell from the equipment; and the second, though commencing with a decided opinion in its favour (the large proportion demanded for the experiments will prove this), came, after patient trial, to the conclusion that it was simply waste of time and ammunition to persevere with it, as it was beaten—and beaten hollow—by every other projectile in all cases; in the end, a large proportion of the rounds supplied were returned unused.

It would appear to be one of the most usual mistakes made in regard to common shell, to suppose that they are effective when the practice is indifferent; the real fact is, that with the very best practice their effect is not to be compared with that of shrapnel shell; with fair practice it is very small and with indifferent practice there is absolutely no effect. It might, indeed, be said that under almost any circumstances, they would be "fired away like blank cartridge, so far as the people aimed at were concerned."

(*c*) The nature of Shrapnel Shell is entirely different. It does not break up and disperse at random, but opens, and allows a large number of bullets to pursue very much the same well-defined path as the shell would have taken had it not ceased to exist as a single projectile. The path of the bullets is compounded of the velocity inherent in the components of the shell at the moment of opening, the centrifugal force due to its rotation, and the force generated by the bursting charge; the two first are quite constant and regular, and although the last is uncertain, it bears but a small proportion to the other two. The shell, therefore, forms a cone very regular in shape, and in the dispersion of the bullets over any given area of its section. The great regularity of effect is most remarkable.

It must be carefully borne in mind that this shell has in its action no affinity with the old Spherical Shrapnel, the Segment, or the Common shells; all these require to be burst near and high up, whereas it must be opened low, and comparatively far off.

The cone of dispersion (8°) is so small, the effect is so directly in the path of the projectile, the velocity and power of the bullets is so long retained, and their ricochet is so effective that, although good practice will materially increase the results obtained, yet indifferent or almost bad practice is never without fair result; in fact, if the action of the shell is thoroughly understood, failure in obtaining effect need never be feared.

In the case of Shrapnel the great supposed disadvantage is the idea that time fuzes must necessarily be used with it. Surely this is hardly the fact; although, undoubtedly, a skilful use of time fuzes will always bring out the full power of the shell yet, when the ground is favourable, at all ranges up to 1700 yds. percussion fuzes will give almost equal results; they can always be relied upon for excellent results up to 2500 yds., and will give fair results up to 3500 yds. In fact, at the shorter ranges, when the "simplest service of the gun is the best," there need be absolutely no difference in the manipulation of common and shrapnel shell.

It is objected that, when fire is passing through or *over* a battery, time fuzes cannot be used; nothing, it must be confessed, is more startling to those Officers of the regiment whose want of good fortune has prevented their seeing actual warfare, than to be told, by those distinguished Officers who have, that so little remains of the cool courage and steadiness which used to characterise our service, and which made its fire so superior to that of its opponents. Many certainly believe that the old form still exists to such an extent that time fuzes may be used intelligently on service if the Non-commissioned Officers and Men are as carefully instructed and constantly practised in their gunnery duties, as they are in others which are certainly not more important; and that in this, as in other directions, the attempt had better be made to increase the excellence of our ammunition even beyond its present power, without fear of getting beyond the intelligence of the men; rather than to debase it, in order not to surpass the low level assumed for them.

Although, to obtain maximum effects with shrapnel shell, the best possible practice is necessary, the same excellence in this respect is not required as is the case with common shell; the certainty of their action, the amount of ground they cover, and the direction in which it is covered, all tend to this.

The difficulty of correct estimation of point of burst is urged, in the Notes, against shrapnel shell only. The difficulty exists to a greater or smaller degree with all projectiles; common shell, from the comparatively large amount of smoke on burst, is the most easy to judge, even it may however be judged indifferently by those who have not had constant practice at this most important part of their duties. This very feature sometimes leads to a false estimate when the objects are small, and the observer is directly in rear of the gun instead of being well on the right or left flank of the battery; common shell practice will, in such a case, seem good even when it is most indifferent.

As long as the puff can be plainly seen, the smaller it is the more likely is a true estimate; and this fact is in favour of shrapnel.

Trial shots, with shrapnel or common shell, should always be made with percussion fuzes; and then, unless the ground is most unfavourable, no more difficulty exists with one than with the other.

As soon as the range is exactly determined, and time fuzes are being used, the heights above plane will show exactly at what distance the shell are being burst. If the object is moving, one gun using per-

cussion fuzes with shrapnel if the ground is favourable, with common shell if it is not so, will keep the commander informed of the changes necessary.

Judging is, of course, more difficult on service than at practice in the case of all natures of projectiles. This is a fact which should make us most careful in hastily adopting conclusions on the effect of projectiles formed under the adverse conditions of actual warfare; because they can but very seldom be supplemented by such closer inspection of the ground and objects as would, by giving the results obtained, either confirm or disprove the theories formed from observations which may very possibly be imperfect.

In what respect then can it be said that common shell is a more "rough and ready projectile" than shrapnel shell? Their manipulation is precisely the same; at all ranges percussion fuzes may be used with either; and the practice need not be so good with the latter as with the former.

It may be as well, in attempting to arrive at the proportions of ammunition carried, to consider the different duties required of field artillery, and the projectiles best adapted for them. They are arranged in the following table, as far as possible in the order of the frequency of their occurrence.

Artillery may be required to act—

1. Against troops in the open, in small bodies or dispersed order—taking advantage only of such cover as is afforded by the accidents of the ground.
2. Against troops in larger bodies, or more compact order, under the same conditions.
3. Against artillery in the open, at considerable ranges.
4. Against artillery in gun pits, or behind natural cover.
5. Against heavy masses of troops, generally at long, but occasionally at short ranges.
6. Against artillery in the open, at short ranges.
7. Against artillery under cover, at short ranges.
8. Against troops or guns under cover of buildings, &c.
9. Against troops posted in woods.
10. Against troops in shelter trenches.
11. Against troops in field works.
12. For the destruction of obstacles such as pallissades, abattis, &c.
13. For incendiary purposes.

The projectiles which all published accounts of experiments concur in recommending for these requirements, are as follows:—

1. Under all circumstances shrapnel in preference to common shell.

2. The same.

3. The fire of hostile artillery may be kept under by injury to men or *matériel*. Its mobility can be destroyed by injury to men, horses, or *matériel*. Every experiment and the experience of the Franco-German war prove fully that common shell has little effect upon *matériel*; compared with shrapnel shell it is useless against men or horses. In a word, for this work shrapnel alone has effect.

4. For this, again, shrapnel has shown its superiority to common shell.

5. A strong belief still appears to remain in the efficiency of common shell for this purpose. It would, however, appear probable that a shell giving a heavy concentrated fire of numerous bullets must be superior to one which has at best only a small number of highly dispersed splinters. Certainly all published accounts tend to prove that this is the case. Shrapnel shell may, therefore, be said to be best for this also.

6 and 7. The same remark holds good as in case 3.

8. Where cover is material affording actual protection, such as buildings, walls, &c., common shell only can be used.

9. Where the cover offers but small actual resistance, as in the outskirts of woods, brushwood, &c., shrapnel shell would doubtless be superior. In other positions common shell, from its greater lateral spread and destructive effect, would be best.

10. For shelter trenches, if the fire is direct, time shrapnel burst slightly high so as to obtain the full effect of the larger angle of descent of the lower half of the cone; or, if the fire is oblique, percussion shrapnel give the best results.

11. Against field works of any strength, field artillery of the power of our guns would have but little damaging effect. As the Dartmoor committee showed conclusively, a 1 lb. bursting charge had only a small effect on earthworks, under that there was little or none. A shell of larger capacity, *and with a gun-cotton bursting charge*, can be the only solution of this question; it would seem impossible that any shell large enough to be effective if filled with powder could be carried in the field. All that field artillery proper can hope to do, is to keep down the fire of the defenders by a heavy shrapnel fire on the parapets, and to weaken or destroy their artillery by the use of shrapnel or common shell, as circumstances may render necessary.

12. For destroying obstacles, common shell must take the first place; percussion shrapnel may, however, be of value in the case of abattis, &c., to complete the destruction.

13. For incendiary purposes also of course common shell must be used.

These conclusions are drawn supposing the guns to be those of the English field service, and the ground such as would be met in ordinary European warfare, or on the plains of India. They cannot, of course, apply to such exceptional positions as mountain warfare, on ground thickly strewn with heavy boulders, especially when ordinary mountain guns are used. In the first place, the shrapnel of these guns is so wanting in velocity as to be almost powerless even under the most favourable conditions, and common shell would therefore generally be the only possible ammunition. In the second place, such ground offers continuous actual cover impervious to the effects of the best shrapnel. The greater the number of small common shell used, and the more vertical their descent the better; our field guns with their flat trajectories would not only be unsuited to such work, but any conclusions drawn from their performances under such conditions would be utterly misleading with regard to their real capabilities for ordinary service.

If these views are sound, it would certainly appear likely that the present proportion is perfectly adapted to ordinary work, although a larger proportion of common shell might, under exceptional circumstances, be apportioned temporarily to batteries destined for any exceptional work such as the attack of villages, farm buildings, &c.

To conclude; the attempt has been made to argue that, compared with common shell, shrapnel is,—

1. Not more difficult to manipulate when percussion fuzes are used.

2. Nor to judge.

3. Far superior in effect at all ordinary objects and ranges.

4. And capable of still greater effect with time fuzes.

With regard to the use of time fuzes, it must further be remarked that,—

a. Batteries are, almost as a rule, not under a fire so heavy as to interfere to any great extent with the coolness of the officers and non-commissioned officers in whose hands the manipulation of the fuzes should really be.

b. And that if the instruction in, and knowledge of, artillery duties were made a stronger point in the service, their manipulation

would become almost a second nature, and that both officers and non-commissioned officers would then not only be able, but eager to obtain at decisive moments the full power of their weapon; they would not, in fact, be satisfied with meagre results more worthy of an ill-armed and unskillful service than one of which has a reputation to maintain.

Among the many valuable results which must be obtained by the increased facilities about to be given for the practice of batteries, it may fairly be hoped that experiment in practical directions will be one. Where such a divergence of opinion obtains as in the question under discussion, two batteries' practice would be worth reams of paper. Let one have the service, the other the proposed armament; let the targets be as closely resembling actual objects as possible, and let both imitate, by an enforced rapidity of fire, the hurry and excitement of service. The results, even if they did not convince either side, would at least throw light on the subject, and could not but be of great practical value.

St. John's Wood Barracks,
September 14th, 1880.

NOTES ON ARMOURED DEFENCES.

A Lecture delivered at the R.A. Institution, on 29th April, 1880,

BY

COLONEL INGLIS, R.E.

Long before the general adoption of rifled cannon by fleets and armies, it was a well recognized fact that the materials then in use for works of fortification were not a match for the guns which ships could carry. Necessity for use of armour

Accordingly, we find that early in this century experiments were made with iron-cased walls, at Woolwich, not to mention others made in much more remote times.

In 1853, extensive trials were made in the United States with smooth-bore guns against masonry structures, having in them embrasures strengthened with iron and other materials.

In 1855, the French employed three iron-cased floating batteries in the allied attack upon Kinburn, and, before peace was made with Russia, England also had iron-clad batteries afloat.

In 1856, iron plates were tried, both in this country and in France, against smooth-bore guns, and, in 1859, a shield for an embrasure, composed of massive iron bars, was tested at Portsmouth for Sir J. Burgoyne, by the fire of 68-pr. service guns; and besides many other trials of smooth-bores against iron about that time, in 1858, two armoured floating batteries were experimented upon at Portsmouth, by 32-prs. and 68-prs.

The fact is, that it was nothing but the vagueness of the fire, and the rapid loss of velocity in the projectiles, of smooth-bore guns, that allowed our works and ships to escape as well as they did in former times. And this applies at least as much to other countries as to ourselves.

In this view, therefore, it is not surprising that, when guns of good range and precision came to be introduced, some great change in the mode of defence should have been commenced.

But it has been urged that the mere fact of the old walls of our works having been found insufficient for the altered fire of artillery should not have condemned the material of which they were composed. If walls of 5 ft. or 10 ft. thickness were not strong enough, let them be made 20 or 30 ft. thick, or more if necessary; and if masonry will not do, use more earth or concrete, or something else in large quantities.

Well, to a great extent, this is really what has been done generally in works of fortification; but in forts for coast and river defence, which are the only works liable to the fire of the heaviest ordnance, and with which alone I have to deal on this occasion, a large addition of mass is altogether impracticable.

The question of strengthening land fronts by means of a partial use of armour, is one that deserves great consideration, and, for my part, I see no reason why an inland fortress should not be rendered practically impregnable, by the judicious use of iron or steel, at no very great additional expense; but I should be attempting too much if I were to introduce these topics into this paper.

In any case, the formation of an efficient embrasure in a very thick parapet involves great difficulties; but in a work exposed to the fire of heavy ships' guns, the strengthening, which becomes necessary in the neighbourhood of the embrasure, involves a treatment which alters the whole character of the work. The main reason however why the necessary strength cannot be gained in coast batteries by multiplying the thickness of the parapets, is that in the great majority of these works the character of the site practically precludes it. For instance, in the case of a fort at sea, it would be obviously out of the question to bring up foundations for an earthwork, or for a work having very thick parapets of other materials; and this difficulty holds good, with a difference only of degree, in most of the sites selected for our coast defence works.

Scope of subject dealt with.

It will be observed, even from what has been already said, that in this paper I am going to deal only with works adapted to guns which fire through embrasures, or ports as they are now called—that is to say, to protected guns mounted on carriages and platforms of the ordinary type.

The general character of the works of which I shall speak, has been, from time to time, determined by the highest authorities, and therefore it becomes obviously my part, as it certainly is my wish, to avoid entering into any discussion as to the merits of the general system which has been adopted in our works, compared with any other methods of mounting and protecting guns in coast batteries which have been advocated.

I propose, broadly, to divide the subject under three heads; that is—

1st. To trace, briefly, the experimental stages through which the question of iron defences has passed.

2nd. To give some account of the materials used in these defences, and of their manufacture.

3rd. To describe, as far as time will allow, some of the principal iron works which we have set up for the defence of our naval arsenals and ports at home, and of our fortresses abroad.

I.—The Experimental Stages.

And, I may say at once that the few early experiments to which I shall refer possess something more than a mere historical interest, because in them is to be found a warrant for every step we have taken in working out a system of iron fortification. Every point, down to those of the nicest detail, has been based on experimental results. I am sure those officers who have watched the experiments at Shoeburyness and Portsmouth, will bear me out in saying that in no subject that has ever been raised has mere opinion, unsupported by practical experience, proved so worthless as in this.

Early experiments with Land service and Ships Targets.

Starting then with events of rather more than 21 years ago, I may say that the first occasion on which rifled ordnance was used experimentally in this, or perhaps any, country against armour, took place at Portsmouth, in the latter part of 1858, when a Whitworth 68-pr., of 5¼-in. hexagonal bore, was fired at 4-in. plates attached to the side of H.M.S. "Alfred," and cast-iron shot, at 400 yds., indented the plates a little more than an inch deep; a wrought-iron shot, at 450 yds., passed through both plate and the ships' side.

The first time that a rifled gun was fired at armour for land works, was in 1860, when an 80-pr. Armstrong gun fired wrought-iron flat-headed shot, and a 40-pr. fired cast-iron shot, at two iron embrasures (8 ins. and 10 ins. thick) fixed in a masonry work at Shoeburyness. This trial brought out the advantages arising from the use of iron for strengthening works, and the disadvantage of having splayed sides in an iron embrasure.

From that time experiments against armour followed each other rapidly.

In 1861, comparative trials were made between wrought-iron armour plates backed with rigid materials, such as cast-iron and granite, and similar plates backed with timber, cork, indiarubber, layers of wire, and other substances. From these it was gathered that while the hard materials improved the resisting power of the armour, they led to its being more injured by cracking and to the giving way of fastenings.

Other trials were made with wrought-iron plates inclined to the horizon at various angles, from which it was concluded that a mass of armour placed upright will offer as much resistance as the same mass disposed at any inclination so as to cover the same vertical area.

Even *wool* was experimented upon as to its power of resisting cannon shot, and I need scarcely say that it failed signally.

Next, some shields, 6 ins. and 10 ins. thick, composed mainly of boiler plates ⅝-in. thick, rivetted and screwed together, gave very indifferent results; and two other heavier casemate shields, of very opposite construction, made of massive slabs of rolled iron, laid one in front of the other, and crossing at right angles, with lead between them, were tried, in 1862–3, with good results.

Of targets representing portions of ship's sides, I find I cannot omit all mention, because so much of the experience gained from them has been useful to our service.

In the "Warrior" target, composed of 4½ ins. of rolled iron plates on 17 ins. of wood, backed by a thin iron skin, we saw the advantage of timber backing, the weakness of joints in armour, and the disadvantage of joining armour plates to each other by means of tongues and grooves on their edges. In other of these ships' targets the question of providing a compound backing of wood and iron instead of wood alone was practically solved in favour of the former, and the disadvantage of doing away with all wood in the backing was also proved.

During the period of which I have now been speaking—that is up to 1863—the heaviest gun used in experiment was a 10½-in. rifled gun, throwing a cylindrical shot of about 300 lbs., with a muzzle velocity of

about 1320 f.s. There was also a 7-in. Whitworth (130-pr.) and a large 13-in. smooth-bore Horsfall gun. But shortly afterwards a 23-ton gun of 13·3-in. calibre, capable of piercing a ship's side, stronger than that of the "Warrior," at 2 miles range with a shot of 600 lbs., called for a corresponding advance in the strength of armoured structures.

Consequently H.M.S. "Hercules" was protected with 9-in. armour at her water-line; and a target representing her at this part, with a very massive backing of teak and iron stringers, ribs, and skin, afforded effective resistance to the gun I have referred to at 700 yds. range, and would have done so at much shorter ranges. This trial showed the advantage of giving depth or thickness to shot-resisting structures.

A method of holding on armour plates by continuous irons turned over their edges instead of by bolts was also tried, but there were objections to it.

Turning again more particularly to the protection of land works, the following experience was gained about this time—that is, in 1865.

Two complete masonry casemates with ports in iron shields were built at Shoeburyness. The masonry was 14 ft. thick, consisting, generally, of a face of 6 to 8 ft. of stone with brickwork behind it, and the side walls and vaulting of the casemates were of brick. The shield of one was a compound structure 12 ft. long, 8 ft. high, and, altogether, 21 ins. thick (including 7 ins. of wood); that of the other was made out of a solid rolled iron plate, 7 ft. high, 6 ft. wide, and 13½ ins. thick. After the mounting, working, and firing of a 23-ton and a 12-ton gun in the casemates, as well as on the roofs, had proved the work to be suitable in arrangement for such guns, the front of the work was attacked by a battery of 7-in., 8-in., 9·22-in., and 10-in. guns, at ranges of 600 and 1000 yds., firing steel and cast-iron shot, some with hemispherical, and some with elliptical heads.

The general result of this trial was that after 33 hits the work began to become untenable, after 54 hits its fire would have been virtually silenced, and after 86 hits, of which 22 were on iron, the masonry front was destroyed, but the shields still afforded a fair amount of protection.

The aggregate of all the blows delivered came to 200,000 ft. tons, of which 52,000 were on iron.

The issue of this experiment was of the utmost importance to the service, because on it were based the decisions (1) that our most advanced and important sea forts should be protected by walls consisting wholly of iron, and (2) that for other coast batteries masonry might be used, but that every gun casemate of these should have a shield affording protection against fire equal, *at least*, to that of its own gun.

Chilled cast-iron projectiles adopted.

Amongst many other trials that took place about this time were those which brought out the excellent qualities of chilled cast-iron for battering projectiles, as proposed by Capt. (now Sir W.) Palliser, and also the advantages of the pointed (ogival) over the blunt (hemispherical) head. For these experiments iron armour placed both directly and obliquely to the line of fire was used; chilled iron, in consequence of these results, almost entirely superseded steel for battering projectiles, for a time at least. As this question, however, has been recently re-opened it will be briefly noticed later on in this paper.

Next in order came a series of trials of plates of steel, and of steel and iron combined; some were of thin layers of steel and iron welded together, others of sandwiches of steel between rolled iron, others of faces of steel welded to iron, and others of steel and iron in reverse order to this; but none of these competed successfully with a simple soft rolled iron plate in resisting chilled iron shot; some plates made entirely of steel were tried about this time, as they had been also years before, but none of them stood at all well. The difficulty of treating steel in large masses, and especially of welding these masses of steel and iron together, had evidently not been mastered up to this time.

Early trials of steel and compound plates.

In consequence of the growing powers of battering ordnance it now became evident that our land works would require walls of considerable thicknesses of armour; but there were two main reasons why very thick armour plates should not be used in them. In the first place the manufacture of a very thick plate is not so complete as that of one of moderate thickness, or at least to make it as complete would involve an enormous increase of cost in plant and manufacture; and, next, the thicker the plates the deeper the joints must be, and therefore the more points of undue weakness will the armour present.

Evidence of thickly armoured walls being necessary.

It therefore became important to see whether the required protection could not be gained without the use of very thick plates.

Against doing this was the prevailing opinion, based chiefly on theoretical considerations, that a single plate of given thickness would offer something like twice the combined resistance of two plates each of half that thickness, or about three times the resistance of three plates making up the same total thickness, and so on.

This view was entirely disputed by those who had to deal with these questions officially, but it became our business to prove its fallacy.

This was done under the following circumstances:—

In 1867, a total thickness of 7 ins. of iron disposed in one solid plate, in two plates of $3\frac{1}{2}$ ins., and in three equal thicknesses, instead of giving resistances of about 100, 50, and 33, gave effects more nearly as 100, 95, and 88, respectively.

Plate-upon-plate system introduced.

Next, a 10-in. plate failed to stop a shot which was stopped by two 5-in. plates, and another 10-in. plate bore out this result.

Again, in a comparison between a solid 15-in. plate and a wall made up of three 5-in. plates, the result was that, although the solid plate gave a somewhat better resistance to a single blow, the three-plate structure stood repeated blows better than the other.

Also, in 1871, two targets representing portions of the walls of ships' turrets were tried at Shoeburyness. The one was protected by single 14-in. plates, the other by two thicknesses of armour, 8-in. and 6-in., respectively, with 9 ins. of timber between them. In other respects the targets were similar. After receiving the same amount of battering, the armour of both was taken off, and the effect upon the inner skin of the two-plate target was unmistakably less than that on the single-plate structure.

It may also be mentioned that, more recently still, a structure composed of three thicknesses of $6\frac{1}{2}$-ins. of iron proved rather superior to a solid $16\frac{1}{2}$-in. plate in stopping the 818 lb. shot of the service 38-ton gun, striking with a velocity of about 1415 f.s.

In thus dealing with this subject it must not be supposed that the formation of iron walls made up of a number of very thin plates was ever advocated by us. The trial of the boiler-plate targets, already mentioned, for ever disposed of that kind of construction.

Surfaces of plates should not be in contact.

Also, it should be mentioned that the above trials of the plate-upon-plate system showed plainly that the most satisfactory results were not obtained when the surfaces of the armour were in contact, but that, on the contrary, some thickness of a softer and more elastic material between the plates was necessary to prevent their breaking under heavy blows.

Best spacing between plates.

To settle the best proportions, quantity, and best nature, of material to be interposed between armour plates, a series of careful experiments was set on foot, and the result was that a uniform spacing of about 5 ins. (to be slightly modified under certain circumstances) between the different plates in all structures was decided upon; and also, although an iron concrete made by working up together cast-iron borings, asphalte, bitumen, and pitch, gave the best result, mainly on account of its great weight, yet brickwork in asphalte, Portland cement concrete, and hard wood, proved so satisfactory that these materials have been adopted, as circumstances required, in all our armoured walls.

It may be well to mention here a very remarkable result that was obtained in the course of the early trials with plate-upon-plate structures.

Void spaces between armour plates.

When void spaces were left between the plates of these structures, it was found that the heads of the Palliser shells collapsed completely under the work they had to do in penetrating them, and, naturally, the effect produced upon the target was thereby very much reduced.

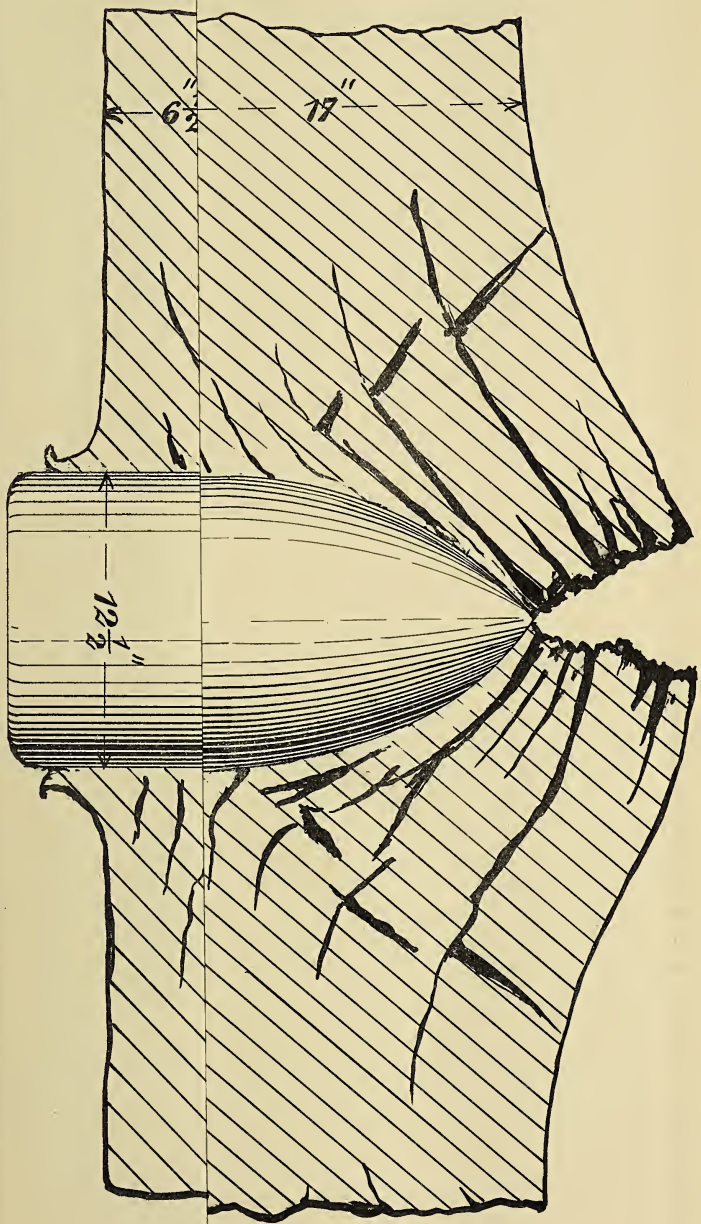
In one case a chilled shot from the 38-ton gun which was capable of piercing 19½ ins. of armour, was found sticking in a finely divided state against a 10-in. plate, after having passed through only a 4-in. plate a few feet in front of it; and on another occasion, a 4½-in. plate, set up 18 ins. in front of a masonry wall, with a void space between them, so far reduced the effect of a chilled cast-iron projectile from the 38-ton gun, at 50 yds., that it broke up on first striking the granite, and was afterwards dug out in pieces at a depth of only about 3 ft. 6 ins. from the original front of the masonry.

Repeated and well-pronounced instances of this utter destruction of chilled projectiles from this cause have been gained and carefully investigated, with a view to turning the principle to some account in defence works; but partly on account of certain difficulties of detail, and mainly on account of the action not being produced on steel projectiles, the idea of using void spacing in practice has been nearly given up.

Perforation of a plate-upon-plate structure compared with that of a solid plate.

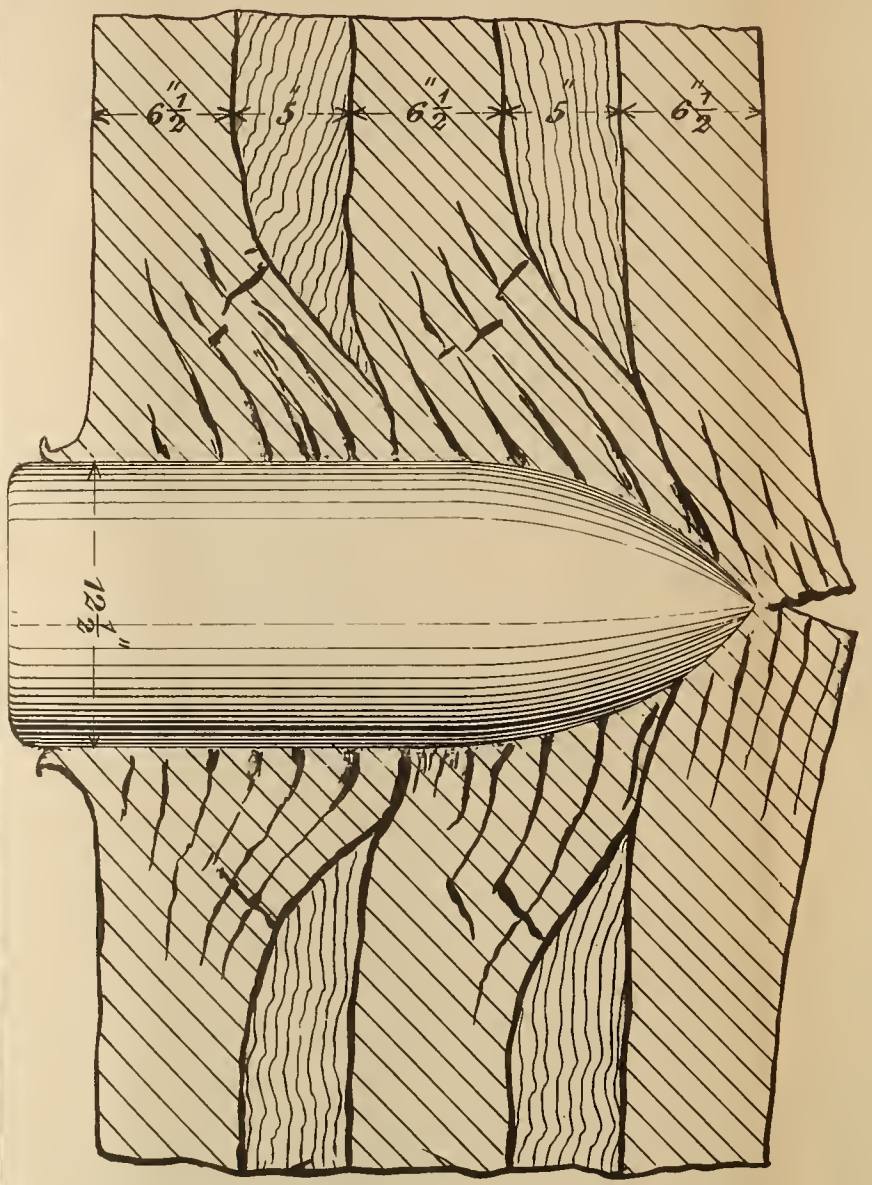
To explain, to some extent, the way in which a well-constructed plate-upon-plate wall offers resistance to a shot, I have had a diagram (No. I.) prepared, from which it will be seen that each plate does not act independently of the other, but that by the back moulds of each one being forced against that next behind it a continuous resistance is offered to the shot during the whole of its passage through the mass. Of course to get the full effect, the several plates must be well held together. To

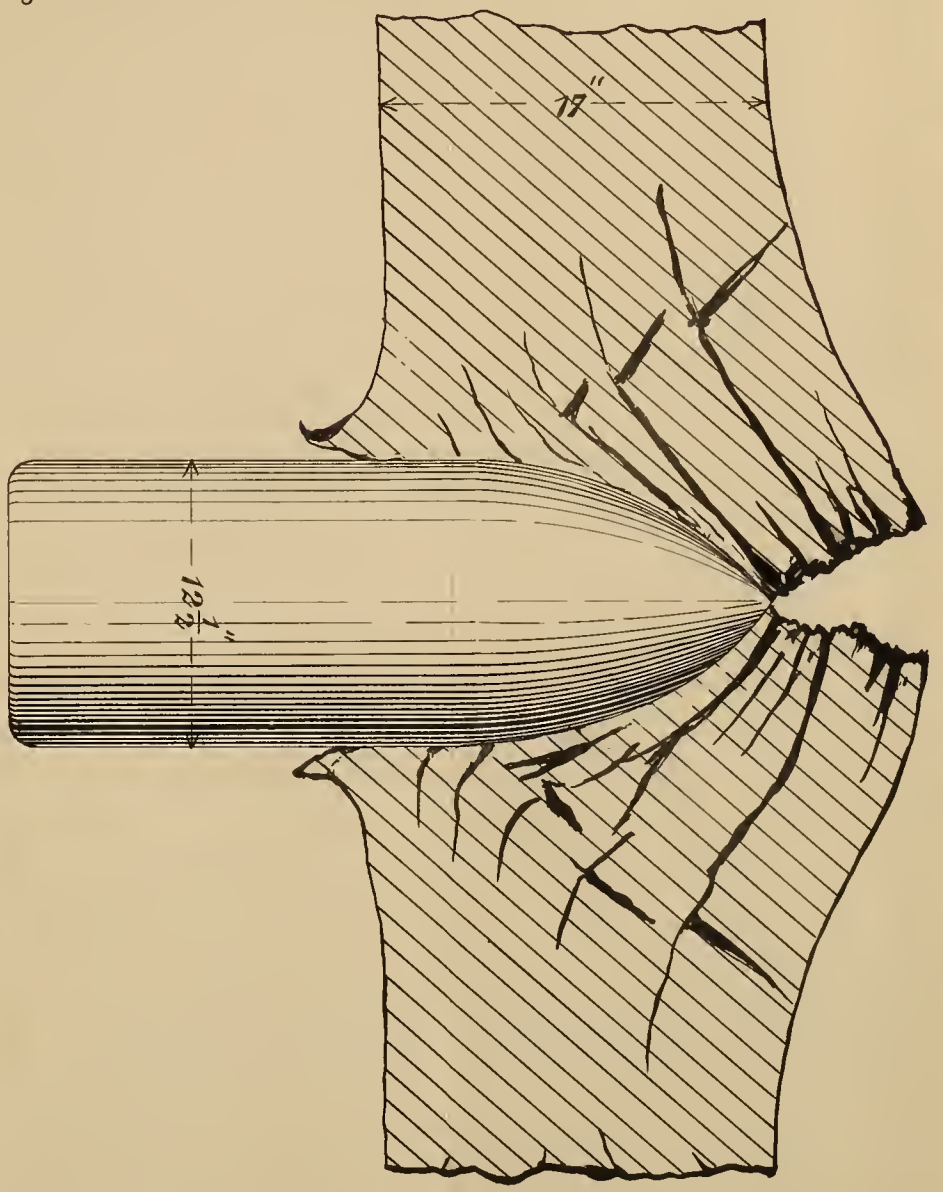
PL. I.



SHOT PENETRATING PLATES.

Scale $\frac{1}{8}$ full size.





help comparison, the diagram shows also a shot in the act of piercing a single plate.

It may be well here to mention that our plate-upon-plate construction is, perhaps, more than any other, proof against what is called "racking action"—that is, the effect of heavy shot striking at comparatively low velocities.

The next trials on a large scale, which influenced our proceedings to an important extent, were those of 1868, at Shoeburyness.

Experimental casemate representing Plymouth breakwater fort.

In these, a casemate, having a front of 22 ft. × 14 ft., representing a portion of the iron fort which was then in course of construction for the position behind Plymouth Breakwater Fort, stood 37 rounds from the 12-in. gun of 25-tons, charge 76 lbs. pellet powder, the 10-in. gun of 18 tons, charge 60 lbs. R.L.G., and the 15-in. Rodman gun of 19 tons, charge 100 lbs. American (equivalent to 83¼ lbs. English) powder, at 200 yds. range; and, although it was of course considerably damaged by this fire, it was, at the end of it, pronounced to be defensible. This trial led to some important additions being made to the front wall of the fort itself, as it went on.

The roof also of this casemate was tested by the fire of 13-in. mortars, at 1000 yds., but they proved quite powerless against it. Only a few shell, however, struck it out of nearly 300 rounds.

Cellular iron fronted casemate.

Adjoining this casemate was another, embodying several kinds of cellular construction in its iron front, with the object of comparing the resistance of moderately thick solid plates with that of thinner front plates supported by cellular compound backing; but, in no instance, did the latter construction prove itself superior to the other. This result was borne out by the trial of another shield in 1868. The support given to armour by massive piers of masonry and concrete, cased in thick boiler-plate, proved very satisfactory.

Armour bolts.

It may be well here to notice briefly the matter of holding on armour plates, on which so much of course depends, and I may begin by saying that of the innumerable contrivances for this object, nothing has been found equal to that of a simple screwed wrought-iron bolt fitted with nuts.

The steps by which the present pattern of armour bolt for fortifications has been arrived at may be thus described :—

At first, a bolt with a deep V-shaped screw thread was used, but, in the early stages of our trials, a shallow round-cut thread was substituted for this with great advantage. Also a gradual and slight cone was adopted in lieu of the abrupt and spreading cone used at first in the heads of these bolts.

Next, Sir W. Palliser's valuable suggestion that part of the shank or stem of an armour bolt should be reduced to the lesser diameter of the thread, led to an immense improvement, and this has been since extended to the whole length of the stem, leaving the thread a plus or raised thread, thus facilitating the extension of the material of the bolt throughout its whole length instead of locally in short lengths.

Then Captain English proposed, first, the rounding of the bearing surface of a common hexagon nut, and, afterwards, the use of a spherical nut seated in a cup-shaped hole in the armour, or in a special

cupped washer; with these improvements, and that of the enlargement of the holes through which the bolt has to pass (all of which have for their object the relief of the bolt from cross strains, and the insertion of a due proportion of elastic material to be squeezed when the bolt is put under tension), all difficulties with bolts have disappeared, and, instead of their being sources of weakness, they really, in most cases, give assistance to the armour.

We have had 3-in. armour bolts of our present pattern, and of moderate length, which only broke at the 7th blow from a ton monkey falling 30 ft., the diameter of the fractured part showing a reduction of 50 per cent., and the greatest extension of any part being from 1 in. to 2 ins.; while the bolts made for our early trials would not stand one of these blows, and broke off quite short, notwithstanding that the iron, in a test machine, had proved ductile and strong. I may say that, with these excellent results, we have been contented with wrought-iron bolts, and have not run the risk of failure with steel bolts.

The special washers are of the following make :—

Coil washer described.

First, a circular washer is made by coiling and welding a bar $1\frac{1}{4}$ in. by $\frac{1}{2}$-in., and this is cupped to suit the spherical nut of the bolt. To strengthen this part, an outer coil of unwelded bar of about the same section is screwed round it: as this outer coil has to expand after the inner coil may have given way, and, as in doing so, it would naturally unwind itself and open out, this tendency to separation has been met by making the thread, by which this outer coil is screwed on to the inner, of quicker pitch than that of its own coils, and thus, as it unwinds, it actually becomes more and more tightly squeezed together.

A diagram (No. II.) of a bolt, completely equipped, is given.

Hammered plates given up.

I must just mention here that, in 1868, a thick wrought-iron plate made by forging under the hammer, proved much inferior to a plate made by rolling, and as there were other disadvantages in the former method of manufacture, it has been entirely superseded by rolling.

Casemate shield of 1870.

All other trials of this period may now be passed over until we come to that of the casemate shield, set up at Shoeburyness in 1870, which embodied all the experience that we had gained from the previous 12 years of experiment.

The guns used were the 12-in. of 25 tons, the 10-in. of 18 tons, the 9-in. Whitworth gun of $14\frac{1}{2}$ tons, and the 15-in. Rodman of 19 tons, at 200 yds.; some rounds were fired obliquely, but most of them were fired direct at the face of the shield.

The shield, which presented a front of 12 ft. by 8 ft., received 17 blows, equivalent to 90,000 ft. tons, and, except in one or two matters of detail, which were susceptible of easy improvement, it stood the trial remarkably well, and proved that it possessed a great margin of strength for these, and even more powerful, guns.

35-ton gun at plate-upon-plate target.

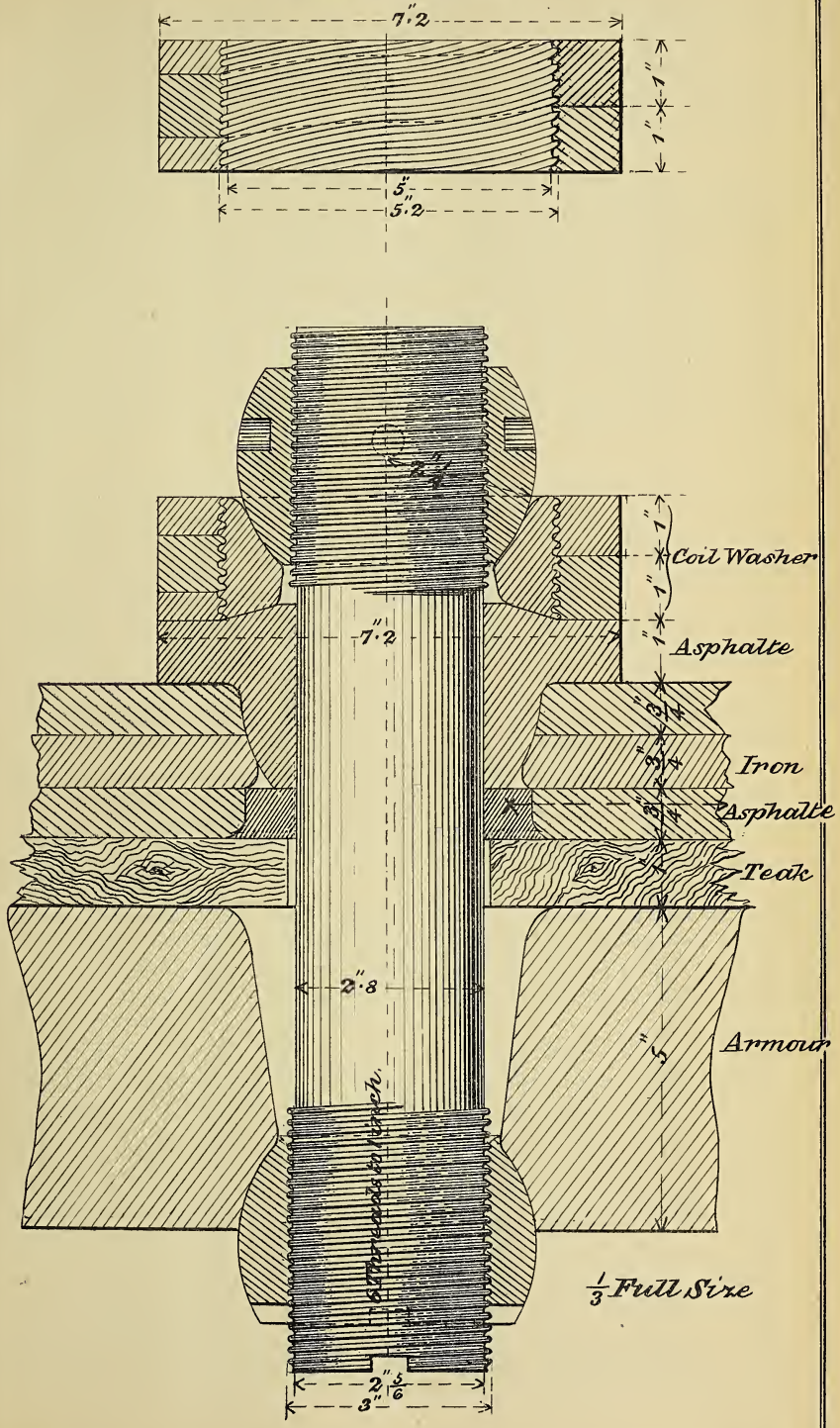
In 1872, a plate-upon-plate target, representing 17 ins. of armour altogether, stopped a Palliser shot fired direct at it from the 35-ton 12-in. gun with 110 lbs. of P. powder; and a similar target with 13-ins. of armour stopped a shot from the same gun, striking it at an angle of 60° with its face.

Turret trials.

As the turret is now an important feature in all projects for coast

PL. II.

ARMOUR BOLT.



defence, and will, I venture to say, maintain its prominence, I cannot omit it altogether in this summary of trials.

In 1861, the cupola of the "Trusty" was tried off Sheerness. It was in the form of a truncated cone, covered with 4½ ins. of armour, and resisted fairly well the guns of those days. The cupola was not damaged in its machinery throughout the trial.

Next, in 1866, one of the turrets of the "Royal Sovereign," carrying armour in thickness from 5½ to 10 ins., was tried at Spithead, with the 12½-ton guns of H.M.S. "Bellerophon." The turret was a good deal injured, but the turning machinery remained in working order.

In 1872, the turret of the "Glatton" was tried, at Portland, with the fire of a 12-in. 25-ton gun of H.M.S. "Hotspur," at 200 yds. range. The armour was 14 ins. thick, and it received two Palliser shot, fired with 85 lb. charges, one of which grazed first on the glacis. There was some damage done inside the turret, but the goat, rabbit, and fowl, which had been placed inside, were unharmed, and the turret turned freely after the trial.

Ships decks. In 1870–1–2, some lengthened trials were made with shot and shell impinging upon ship's decks, which gave some decided results, namely, that a 13-in. mortar shell, at 4,200 yds. range, would go easily through a strong ship's deck covered with 1½-in. plating and 4½-in. wood planking, and that at 2,800 yds. it would go through it if covered with 1-in. plating; that 9-in. *live shell* from the 12-ton gun striking at an angle of 8° is too much for a similar deck covered with 1½-in. plating at short range, but the same deck will just turn a 9-in. *shot* at the same angle. Also, that a strong deck covered with 3-in. plating and 4 ins. of oak, was only just proof against 10-in. shells fired with battering charges from the 18-ton gun, and striking at an angle of 10°.

I venture to suggest that more information is required under this head, as regards the effect of later and heavier guns.

A space must now be devoted to the experimental results of the more recent times.

Later experience as to the perforating powers of guns. Without wishing to promote your field guns into the ranks of armour-piercing ordnance, I may just mention here that the new 13-pr. M.L. gun has, quite lately, proved itself capable of piercing a 4½-in. iron plate with a special solid chilled iron shot, firing its service charge at short range—say, 100 yds.

The rule, that roughly held good a few years back, that battering guns could not, at the shortest range, do more than pierce iron armour plates equal in thickness to their own calibre, has been quite upset in the last year or two by practice from the new long guns, with bores of 23 and more calibres in length. Thus, a 6-in. gun of less than 4 tons weight, and an 8-in. gun of less than 12 tons, have pierced within an inch of double their calibre in thickness of solid iron plate; and calculations tend to shew that the projected long B.L. guns of 9·2-in. of 18 tons, the 10·4-in. of 26 tons, and the 12-in. of 43 tons weight, will achieve fully as much as this, if they are successful in other respects.

Speaking generally, the service guns were always capable of doing somewhat more than is indicated by the old rule abovementioned, and if, with the improved powders of the present day, their charges can

with safety be increased to the extent which, I believe, has been proposed for them—as, for instance, 90 lbs. P^2 for the 10-in. 18-ton gun, 110 lbs. P^2 for the 11-in. 25-ton gun, and 160 lbs. P^2 for the 12½-in. 38-ton gun—then these guns will be nearly, if not quite, able to pierce, at short range, a thickness of solid iron equal to 1½ times their calibre.

While upon this subject, I may say that no great advance has been made in late years towards determining a *law* for the resistance of armour, nor do I think that, for practical purposes—whatever may be the case from a scientific point of view—much good will come of enquiry in this direction. The conditions and effects are altogether too variable and uncertain for the construction of mathematical formulæ. For instance, in recent practice, under apparently similar conditions of projectiles and plates, there has been an unaccounted-for variation of effect of something like 5 per cent. plus or minus.

But we can, by building upon results obtained with one gun, say within a little what another gun will do, and so construct tables of penetrations for all velocities, or, in other words, for all ranges. I will not, however, go further into this matter now than to mention one or two approximate rules which may be easily borne in the memory. Thus, with the average service conditions of weight and length of battering projectiles, a shell of good quality, with a velocity between 1050 to 1150 f.s., will pierce solid iron equal in thickness to its own calibre; with a velocity between 1500 and 1650 it will pierce iron of a thickness equal to one and a half times its calibre; and with a velocity between 2000 and 2200 it will pierce solid iron equal in thickness to double its calibre. To obtain the latter degree of perforation at the muzzles of the latest guns, the powder charges must, I believe, be equal to, at least, one-half the weight of the shot.

I have already had occasion to mention that a target composed of three thicknesses of 6½-in. rolled iron plates, with layers of 5 ins. of teak between them, was used against the 38-ton gun.

This gun just perforated this target when firing its service Palliser shot with 130 lbs. of P^2 powder, at 70 yds. range, striking velocity of shot 1420 f.s., ft. tons = 11,400; but when a fourth 6½-in. plate was added to the target, it was a good deal more than a match for the same gun after it had been chambered, when it fired 200 lbs. P^2 powder, striking velocity of shot 1525 f.s., ft. tons = 13,000.

A solid 16½-in. iron plate resisted the 38-ton gun nearly as well as the three 6½-in. plates did, and it was also nearly pierced by a shot from the long 8-in. gun (Armstrong) already spoken of, firing an exceptional charge of 111 lbs. P. powder, at short range.

A Palliser shot, fired from this (38-ton) gun with 130 lbs. P. powder, went through a wall composed of 5 ft. 6 ins. of granite and 6 ft. of brickwork, but the wall had been shaken by previous practice.

At Gâvre, in 1876, a Whitworth 35-ton gun of 12-in. (maximum) calibre, fired with 120 lbs. P. powder, is reported to have sent a flat-headed steel shell of 808 lbs. through two 8-in. plates; but our experience with flat-heads would not lead us to expect so much effect upon a well-constructed two-plate target of this thickness.

I may say at once, that neither with direct nor oblique fire have flat-headed shot proved themselves, in our trials, at all equal to pointed shot in piercing armour.

In 1877, a target, composed of four 8-in. rolled iron plates, with layers of 5-ins. of teak between them, was set up, at Shoeburyness, for the trial of the 80-ton gun of the pattern made for H.M.S. "Inflexible," and for the turret on Dover Pier. Two rounds were fired—one before, and one after the gun had been chambered. The Palliser projectiles weighed 1700 lbs. The range was 120 yds. In the one case the shot was fired with 370 lbs. P^2 powder, and struck with a velocity of 1495 f.s., and total energy of 26,400 ft. tons; in the other, 425 lbs. P^2 powder gave a striking velocity of 1585 f.s., and an energy of nearly 30,000 ft. tons.

In neither case was the target perforated, though, as the shot had got their noses an inch or two into the back plate, it was a good deal cracked and bulged behind. Had the plates been 7 ins., instead of 8 ins., thick, probably the last shot, at any rate, would have got through.

I abstain from noticing, in much detail, the trial of an armoured target at Meppen, last year, for the same reason that I have excluded many of our own experiments—namely, because the results were, from various causes, of an inconclusive character.

The target in this trial consisted of two wrought-iron plates, thus—

Front plate, 12 ins. thick, 16 ft. 4 ins. long, 3 ft. 9 ins. wide,
Rear " 8 ins. " 18 ft. long, 5 ft. 4 ins. "

with an interval of 3 ins. between them, lightly filled with wood (fir, I believe).

The gun was Krupp's long 24^{cm} gun; the projectiles were of steel; the charges and velocities were as follows:—

Projectile. lbs.	Powder, Prismatic (1 hole). lbs.	Velocity, striking. f.s.	Striking energy. f.t.
348·3	165·3	1876	8508
346·5	"	1852	8244

The front plate proved to be very brittle, and the rear plate was much underwelded.

In each case the shot went clean through and some 2000 or 3000 yds. beyond the target.

This easy victory by the shot may be accounted for, partly by the inferior quality of the plates, and partly by the bad arrangement of the target, which was not bolted together, I believe, and which certainly had too small an interval between the plates.

The gun used in this trial is only equal to perforating an 18-in. solid wrought-iron plate at its muzzle, and therefore should be only just capable of getting its shot through a well-constructed target of two plates making up together 20 ins.

It will be observed that I have hitherto been dealing mainly with experiments on wrought-iron armour. I wish now to say a few words on other kinds of armour.

And first, with regard to cast-iron:—

Chilled cast-iron armour.

As early as 1867, we tried, at Shoeburyness, some iron blocks cast in chill. In these the extreme hardness of the chilled surface was well illustrated, but the brittleness was so marked that we hesitated to go further with this kind of protection.

But it was taken up in Prussia, and in 1869 a chilled cast-iron casemate front, egg-shaped, (thickness of metal about the port, 27-ins.) underwent a considerable trial, at Tegel, with 72-prs. and 96-prs., and it stood fairly well. The indents were very slight, but the material, as usual, was extremely brittle, and, to adopt the expressive language of a report quoted in the professional papers of the Corps of Engineers, U.S. Army, it was "pretty well cracked up."

The next trial of chilled cast-iron armour was at Magdeburg, in 1874, against a very massive rounded target made by Grüson, and, although both from the form of the structure and the hardness of the material, individual shot were very effectually turned off it, yet repeated blows caused serious injury.

Still, the Germans and Belgians have adopted this mode of construction for both shields and turrets—especially for a number of 21^{cm} and 28^{cm} breech-loading muzzle-pivoting guns for the defence of the mouths of rivers. Some of the other European powers also are using it, to a greater or less extent, for both inland and coast fortresses.

The chief advantage of this material is that it can be made of any shape, and therefore rounded and sloping surfaces can be presented to the shot; and it affords also a certain facility for varying at will the thickness of the metal in the different parts of a wall.

The problem is whether for a given sum of money greater efficiency and more complete protection can be obtained by means of cast-iron than with wrought-iron, and nothing but a fair trial between two structures under heavy fire can, in my opinion, solve this.

I must not omit altogether to mention that a chilled cast-iron block was used last year in the Meppen trials, but I am afraid it did not afford much reliable information.

It must be borne in mind that the guns protected by cast-iron walls must be muzzle-pivoted, and also almost of necessity breech-loaded.

Steel and compound armour again tried.

Next, as to experiments with steel, and compound steel and iron, armour.

Even as early as in 1859 armour-plates of mild steel and steely iron, and iron and steel combined, and various kinds of steel plates tempered in oil and water had been tried, and all failed in a greater or less degree when they came to stand the test of shot blows.

I have already said that when the employment of steel for armour was taken up again in this country in 1867, the steel was beaten by simple wrought-iron plates.

And so the matter of steel armour rested until the Italians in 1876 boldly re-opened the question by setting up two armour plates (made by M. Schneider, of Creusot) of soft forged steel 21$\frac{3}{4}$ ins. thick, for trial at Spezia. The plates were about 11 ft. long and 4 ft. 7 ins. wide, and they were backed with massive oak covering a strong iron skin well supported in rear.

For comparison with these, three iron plates of nearly the same dimensions as the steel plates, and similarly supported, were tried at the same time, as well as two plate-upon-plate targets, each consisting of iron plates 11·8 ins. and 9·8 ins. thick, with 12 ins. of wood between

them, and backing of timber and iron behind them. I must also mention two targets composed of 8-in. wrought-iron plates backed by blocks of chilled cast-iron of "Gregorini" metal, 14 ins. thick. In one of these the chilled blocks touched the front armour, in the other 12 ins. of wood were interposed.

In all the targets there was the same total thickness of 4 ft. 4 ins., made up of about 22 ins. of armour and 30 ins. of timber and skin.

The general result of the trial was this:—

One steel plate was a good deal cracked, and had its end knocked away by two blows from a 10-in. and one from an 11-in. gun throwing chilled cast-iron projectiles, and the fourth round from the 100-ton gun with a 2000-lb. chilled cast-iron projectile striking with a velocity of 1500 f.s., and a muzzle energy of 31,000 ft. tons, dashed the plate to pieces, though it apparently could not quite perforate it. The other thick steel plate was completely demolished by a single round from the same 100-ton gun.

The thick wrought-iron plate made in England was much less injured generally by the lighter guns than was the steel plate, though the indents in it were deeper, but the 100-ton gun sent its shot through all the iron plates, and also broke them in two.

The "plate-upon-plate" targets did not do so well as the solid plates, and the targets with the chilled iron backings entirely succumbed to a single blow on each from the 100-ton gun.

The results of the trial were seriously invalidated by the narrowness of the plates used; a width of 4 ft. 7 ins. being altogether too little for a plate which is to receive a 17-in. shot, and, on this account, these costly and elaborate trials at Spezia have afforded much less useful information than they ought to have given.

The brittleness of the steel, and its consequent incapacity for resistance to repeated blows, is a striking feature of these trials; the failure of the plate-upon-plate targets, through their being a bad imitation of our construction, is another; the utter collapse of the target with the chilled iron blocks is a third; and the defective plan of holding armour by simply screwing bolts into the backs of plates is a fourth.

It is to be regretted, also, that these trials did not give us a more exact measure of the armour-piercing power of the 100-ton gun, which was a counterpart of the four which we are to mount at Gibraltar and Malta.

In 1879 the Italians again experimented at Spezia upon thick steel plates.

This time the plates were nearly 28 ins. thick, and were entirely cased in 1-in. plate boxes, which dispensed with bolting. They were narrow plates, as before (4 ft. 7 in. wide and 9 ft. long), weight about 20 tons each; but these plates were so utterly destroyed by a single round each, from chilled iron or steel projectiles from the 100-ton gun firing 550 lbs. of Fossano powder, that the trials had to be discontinued without telling much more than was known before. The forged steel projectile made by Whitworth seems to have penetrated the deepest (21·65 ins.), and remained entire, but it was somewhat set up.

It is understood that the Italians will continue these trials of armour-plates shortly.

With the earlier collapse of simple steel armour before us, our English manufacturers were set to work, in 1877, to see if they could not produce something which, while it should have the resisting qualities of steel, should be free from the serious defect of breaking up under almost a single heavy blow.

In the course of that year and the following, therefore, we tried every possible kind of armour that could be produced in Sheffield for this purpose.

I think more than 50 methods were subjected to trial. Some were utter failures, some promised well at one time and failed at another, but the result of the whole has been that compound plates, in which a steel face (about one-third the thickness of the entire plate) has been perfectly welded to a wrought-iron back, without injuring the two materials, have met with most success.

The object of this kind of armour is, that while the face shall be sufficiently hard to break up, or to take a great deal of work out of, the shot, the soft wrought-iron back shall hold the mass together, in spite of the cracking of the steel face.

One of the principal points, of course, has been to determine the best degree of hardness, or, in other words, the best proportion of carbon that should be given to the steel for these purposes.

As this matter is still under consideration, I cannot say more about it on the present occasion than that the manufacture of these compound plates can scarcely yet be said to be uniformly successful, but that when they are good they seem to offer, for a few moderately severe rounds at least, resistance compared with that of plain wrought-iron plates as 4 to 3; that is to say, a 9-in. compound plate will be about equal to a 12-in. iron plate, and, with oblique fire, they certainly are very successful in turning and breaking up shot of all kinds of form and material.

The trials have been made principally with 7-in. and 9-in. guns, with both direct and oblique fire, and with all kinds and forms of projectiles, and these are shortly to be continued for the Admiralty, at Shoeburyness, with much greater thicknesses of armour, for which the 38-ton gun is to be used.

Within the last few days the French have carried on important trials at Gâvre, when some steel plates, averaging 18 ins. in thickness, produced by foreign makers, and a foreign-made wrought-iron plate with a hard face, and a compound plate made by Messrs. Cammell, of Sheffield, were fired at by a 32^{cm} steel B.L. gun with 760-lb. projectiles and 210 lbs. charge of powder, and so far as my information goes, the English compound plate behaved the best of all. The steel plates broke up very freely, as usual.

Until further experience has been gained with heavy blows from large projectiles of hard material, it would not be wise to speak confidently as to the ultimate success of this kind of armour.

In the meantime the Admiralty have adopted 9-in. compound plates for the turrets of H.M.S. "Inflexible." The French I hear are seriously taking it up for their ships, but we have not yet decided to use any of this kind of armour in land works.

The use of these compound plates will involve a new mode of fastening them, because bolt-holes passing through the steel would be inadmissible; but we hope we have got over all difficulty in this respect by screwing into the wrought-iron back a seat for a spherica nut to hold the armour bolt without confining it laterally.

A plate, on a novel principle, made by Sir J. Whitworth, deserves notice, notwithstanding that it did not succeed very well. It was composed of a mass of fluid-compressed steel, pierced all over, at regular intervals, by screwed plugs of an extremely hard steel, so arranged that, wherever a shot might strike, it would have to cut into one of the hard plugs.

Behaviour of battering projectiles of various kinds.

Perhaps I shall now be expected to say a few words as to the effect of the different kinds of armour upon battering projectiles of various makes and forms.

First, then, it may be said that although chilled cast-iron shell nearly always break up on striking wrought-iron armour directly at high velocities, yet in doing so they seem to lose very little of their useful energy, and in both direct and oblique fire against this armour chilled cast-iron shells hold their own fairly well against other kinds of projectile.

The only instance in which I have seen any kind of projectile strike thick iron armour obliquely (angle from normal 30°) at a velocity of over 1500 ft. per second, and remain entire, was that of a 9-in. forged steel shell made by Whitworth.

The following are the most noticeable instances of chilled cast-iron projectiles remaining entire after doing good work upon wrought-iron armour hitting directly :—

Round.	Calibre.	Weight. lb. oz.	Plate.	Striking velocity.
2332	3 ins.	10 4	4½ ins.	1699 f.s.
2165	6 "	80 0	5 "	1026 "
2249	8 "	182 8	8 "	1108 "
2260	8 "	182 8	10 "	1337 "

Both forged and cast steel shell, well tempered, have been passed through great thicknesses of wrought-iron in direct hitting without being injured; the same 9-in. forged shell of Whitworth fluid-pressed steel has been passed three times through 12 in. wrought-iron armour plates without breaking up, and a forged steel shell, hardened in oil, from the 8-in. long gun (Rd. 2284) remained entire and very slightly altered in form in a 16½-in. iron plate which it struck with a velocity of over 2200 ft. per second. The chief advantage to be gained by the use of these very costly steel projectiles over the simple chilled cast-iron projectiles appears to lie in the possibility of their being used for carrying a bursting charge of gun-cotton, or some such violent explosive, through thick iron armour before explosion. This the chilled iron shell can never do.

As to the effect of chilled cast-iron armour upon projectiles, there is not sufficient known at present to admit of much being said about it.

On steel-faced armour the best effect has been obtained with cast-steel shell in direct fire, and perhaps rather the best effect with

forged steel shell in oblique hitting, but in this latter mode of attack on steel, all steel projectiles that have been yet tried have gone to pieces.

Steel-faced armour completely baffles chilled cast-iron projectiles.

For direct fire, the longer the head of the projectile the greater will be the effect on iron armour, but in oblique fire the best effect has been produced with heads struck to a radius of two diameters of the shots body.

As I have already said, flat heads are much inferior to pointed heads in both direct and oblique fire.

II.—Account of the Materials used for Armour and their Manufacture.

Manufacture of wrought-iron armour plates.

Beginning with wrought-iron armour :—For this, as made at Sheffield, the best cold-blast pig with a proportion of Cumberland hæmatite is generally used. Roughly speaking, it takes 2½ tons of pig, or 2 tons of ball furnaced iron—that is, of puddle ball—to make 1 ton of finished armour plate, and in the last heating of all, when the iron is in a very costly state, there is a loss by the actual burning away of the iron of about 10 per cent. It takes also about 6½ tons of coal to make a ton of armour.

Perhaps the shortest way of giving an account of the manufacture of rolled iron armour will be to say how some one plate in particular has been made, and I will select for this purpose one of the heaviest ever produced.

This was one of the 8-in. plates made for the target to test the 80-ton gun at Shoeburyness. Its finished dimensions were—length 16 ft., width 10 ft., and its weight 23 tons.

For its manufacture 1170 slabs 30 ins. long, 12 ins. wide, and 1 in. thick were made from the puddled ball and bar. These were piled, furnaced, and rolled into 65 plates about 5 ft. square and from 1 in. to 1½ in. thick, called small moulds. These, again, were piled and rolled into quarter-moulds, and the quarter-moulds into armour-plate moulds, and the pile for the last rolling was made up of three moulds about 10 ft. square, two of 7-in. and one of 3-in. thickness. As they entered the furnace for this last heating they weighed about 35 tons; as they came out after about 12 hours they weighed 31½ tons.

They were rolled down in the last rolling from 17 ins. to 8 ins.; so that, in a certain sense, this plate may be said to have been made by rolling a column of iron nearly 100 ft. high down to one only 8 ins. high. The fibrous character of a plate depends largely upon the amount of reduction in the last rolling.

The rolls are plain cast cylinders; those used in the present case are about 3 ft. in diameter, 12 ft. long, and each one of the pair weighs nearly 20 tons. They are driven by very powerful steam machinery, and made to reverse their running, so that the plates are sent through one way and then back again, and so on, the rolls being brought nearer together each time, until the plate is brought down to the required thickness.

The specific gravity of a good iron armour plate is about 7·625.

Armour plate iron is not made for very high tensile strength, but it is essential that it should draw out well, and reduce in cross section some 20 or 30 per cent. before breaking.

It has been our practice to prove a very large proportion of the plates made for iron fortifications by shot capable of nearly perforating them. Pieces of those which could not be thus proved have been broken under hydraulic presses, and otherwise treated.

Armour bolt-iron is similar to armour plate-iron, but we require a reduction of area of fracture of at least 40 per cent. when broken by a falling weight test, and we generally get a larger reduction than this.

As forged (hammered) iron-armour plates are obsolete, I need not describe their manufacture.

Manufacture of chilled cast-iron armour.

As regards chilled cast-iron there is not much to be said, further than that Herr Grüson, the principal manufacturer of it, runs his blocks, for fortifications, direct from cupolas into sand moulds, chilling the faces which are to form the fronts of the blocks against masses of cast-iron. Some of the chills are twice the weight of the casting itself; the chill generally extends two or three inches into the metal. Single blocks have been used as heavy as 50 tons. The cost of these blocks may be taken as rather more than half the cost of wrought-iron armour plates per ton, but then the cast-iron has to be used in masses more than twice the thickness of the wrought-iron which would give the same protection.

Manufacture of compound plates.

With regard to compound plates there is more to be said, but I must condense it into a few words.

All the most successful compound plates have been made of ordinary armour plate iron faced with Bessemer steel. Of course an equally, or even better, face might be given by using crucible steel, but the cost and difficulty attending the use of this kind of steel would be enormous. In fact, I think it may be said that but for the Bessemer and Martin-Siemen's processes, it would have been practically out of the question to make compound plates at all.

The most simple and effective process of manufacture of these plates is as follows :—

First, a rolled iron armour-plate of the usual quality is made, and on it is laid round its edges a wrought-iron frame, the thickness of the armour-plate and the depth of the frame depending upon the thickness required in the finished plate.

The plate and frame are then placed in an ordinary plate-heating furnace, and when at a welding heat they are brought out, and molten steel made by the Bessemer process is poured out of large ladles on to the surface of the plate up to the brim of the frame. The mass is then allowed to cool, and is afterwards re-heated and rolled down into an armour plate of the desired thickness. The edge of wrought-iron is afterwards planed off. Instead of having a simple frame round the edges of the plate it has been proposed to subdivide the surface into squares, as those of a chess board, in order that, by breaking the continuity of the steel, the cracks caused by shot blows may be stopped short, and with the same object an officer of R.A. has proposed to subdivide the steel by fine cuts across its face ; but we have not yet seen the effect of these expedients in actual trial.

The successful union of the steel and iron masses in these plates is very marked. A complete fusion seems to take place, and the natures of the two metals so far intermingle that it is sometimes hard to fix upon an exact line where the steel ends and the iron begins.

The degree of hardness most suitable for the steel in these plates is supposed to be obtained with about 0·6 per cent. of carbon.

It is thought that the thickness of steel in a compound plate should be between $\frac{1}{4}$th and $\frac{1}{3}$rd of its entire thickness.

III.—Description of the Principal Armoured Defences set up.

I now come to the third and last part of the subject, which comprises a brief description of the principal armoured works erected by us.

The following tables give the number and nature of the guns for which protection has been provided, up to the present time, in each fort or battery at home and abroad, as well as a short description of the iron protection itself.

From these it will be seen that at home 434 guns, ranging between the 7-ton and 80-ton, have been provided for, and abroad 91 guns between the 12-ton and 38-ton, making altogether a total of 525 battering guns behind armoured walls.

Nature of iron protection.	No. of guns.	Description of guns.
Home Stations:—		
Shields in masonry work	7	7-in., 7 tons.
	110	9 " 12 "
	103	10 " 18 "
	42	11 " 25 "
	29	12½" 38 "
Do., do., with guns on turntables	2	10 " 18 "
Iron batteries	54	10 " 18 "
	85	12½" 38 "
Turret	2	16 " 80 "
Total	434	
Foreign Stations:—		
Shields in masonry work	28	9 " 12 "
	39	10 " 18 "
	2	11 " 25 "
	9	12½" 38 "
Do., do., with guns on turntables	6	12½" 38 "
Iron batteries	5	10 " 18 "
	2	12½" 38 "
Total	91	
General total	525 guns	

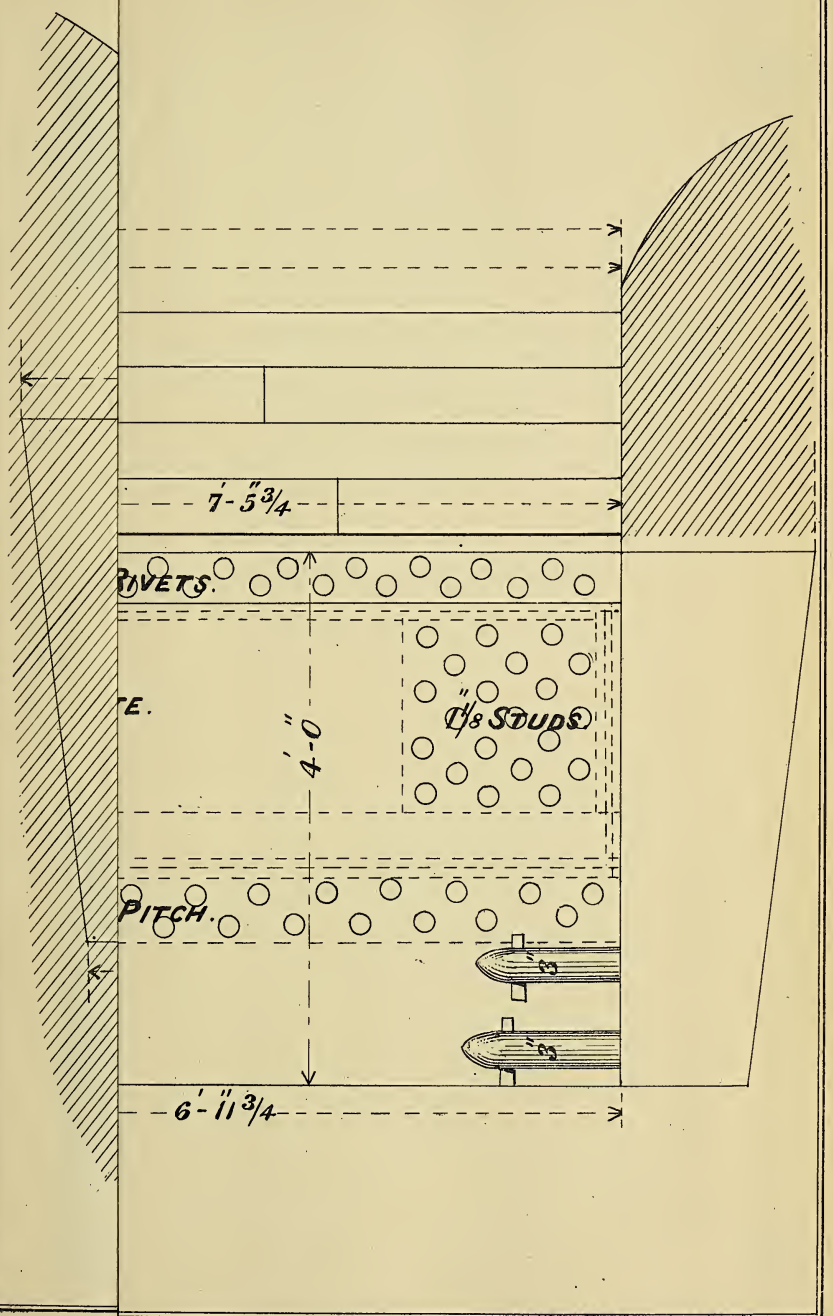
Home Stations.

Name of station and battery.	Nature of iron protection.	Description of guns.					
		7 in. 7 tn.	9 in. 12tn	10in 18tn	11in 25tn	12½ in. 38-ton	16in 80tn
Portsmouth. Gilkicker battery	Shields. Three 5-in. plates, and frame 1′ 7½″ deep.	...	4				
Portsmouth. Horse Sand Fort and No Man's Land Ft.	Iron front. Two 5-in. and one 7-in. plate at ports, three 5-in. plates elsewhere, backing bars 12″ deep, and piers.	...	...	25	...	24	
		...	...	25	...	24	
Portsmouth. Spit Bank Fort	Iron front. Three 5-in. plates; prepared for fourth plate.	...	...	...	...	9	
Portsmouth. St. Helen's Fort	Curved front. Three 5-in. plates, and frame 1′ 4″ deep. Guns on turntables.	...	...	2			
Portsmouth. Do., do.	Straight front. Three 8-in. plates.	...	...	...	...	1	
Portsmouth. Hurst Castle	Shields. Three 5-in. plates, and frames 1 7½′ and 2′ 1″ deep.	...	5	23	...	10	
I. of Wight. Sandown Fort	Shields. Three 5-in. plates, and frame 1′ 7½″ deep.	...	...	8			
Portland. Portland Breakr Fort	Iron front. Three 6½-in. plates.	...	...	...	...	14	
Portland. Nothe Fort	Shields. Three 5-in. plates, and frame 1′ 7½″ deep.	...	4	6			
Plymouth. Bovisand Battery	Do., do., do.	...	9	14			
Plymouth. PlymouthBreakrFt.	Iron front. Outer thickness 5-in. plates, second and third do., 5-in. bars, backing, bars 12′ deep; extra 5-in. plate at ports.	...	...	4	...	14	
Plymouth. Picklecombe Batt.	Double tier shields. No. 15 with three 5-in. plates, and No. 4 with two 5-in. plates; prepared for third plate.	4	19	19			
Plymouth. Drake's Island Bat.	Shields. No. 2 with three 5-in. plates, and No. 7 with two 8-in. plates; frames 1 7½″ deep.	...	9				
Pembroke. Stack Rock Fort	Shields. Three 5-in. plates, and frames 1′ 7½″ deep.	...	...	16			
Dover. Admiralty Pier	Turret. Three 7-in. and two 2-in. plates.	...	...	...	...	...	2
Mersey. Seaforth Battery	Straight front. Two 8-in. plates; provided for third plate.	...	...	...	...	4	
Thames. Coalhouse Fort	Shields. No. 13 with three 5-in. plates, and No. 4 with two 5-in. plates; provided for third plate. Frames 2′ 1″ deep.	...	...	...	13	4	
Thames. Cliffe Fort	Shields. No. 6 with three 5-in. plates, and No. 2 with two 5-in. plates; provided for third plate. Frames 2′ 1″ deep.	...	...	...	6	2	
Thames. Shornmead Fort	Shields. Two 5-in. plates; provided for third plate.	...	...	...	11		
Thames. Tilbury Fort	Shields. Two 5-in. plates; provided for third plate; 1′ 7½″, and 2′ 1″ deep.	...	7	...	1		
Thames. New Tavern Fort	Do., do., do.	...	6	...	1		
Medway and Sheerness. Garrison Point Ft.	Double tier shields. No. 3 with three 10-in. plates on lower tier, and two 9-in. plates on upper tier; No. 34 with three 5-in. plates, and No. 4 with two 5-in. plates; provided for third plate.	...	28	10	3	3	
Medway and Sheerness. Hoo Fort	Shields. No. 4 with two 8-in. plates, and No. 7 with one 8-in. plate; provided for third plate.	...	11				
Medway and Sheerness. Darnet Fort	Shields. No. 6 with two 8-in. plates, and No. 5 with one 8-in. plate, provided for second plate.	3	8				
Harwich. Landguard Fort	Shields. Three 5-in. plates, and frames 1′ 7½″, and 2′ 1″ deep.	...	...	5	...	5	
Cork. Carlisle Fort	Shields. No. 3 with two 8-in. plates, and No. 2 with three 5-in. plates, frames 1′ 7½″ deep.	...	...	2	3		
Cork. Camden Fort	Shields. Two 8-in. plates, and frames 1′ 7½″ deep.	...	...	...	4		

Foreign Stations.

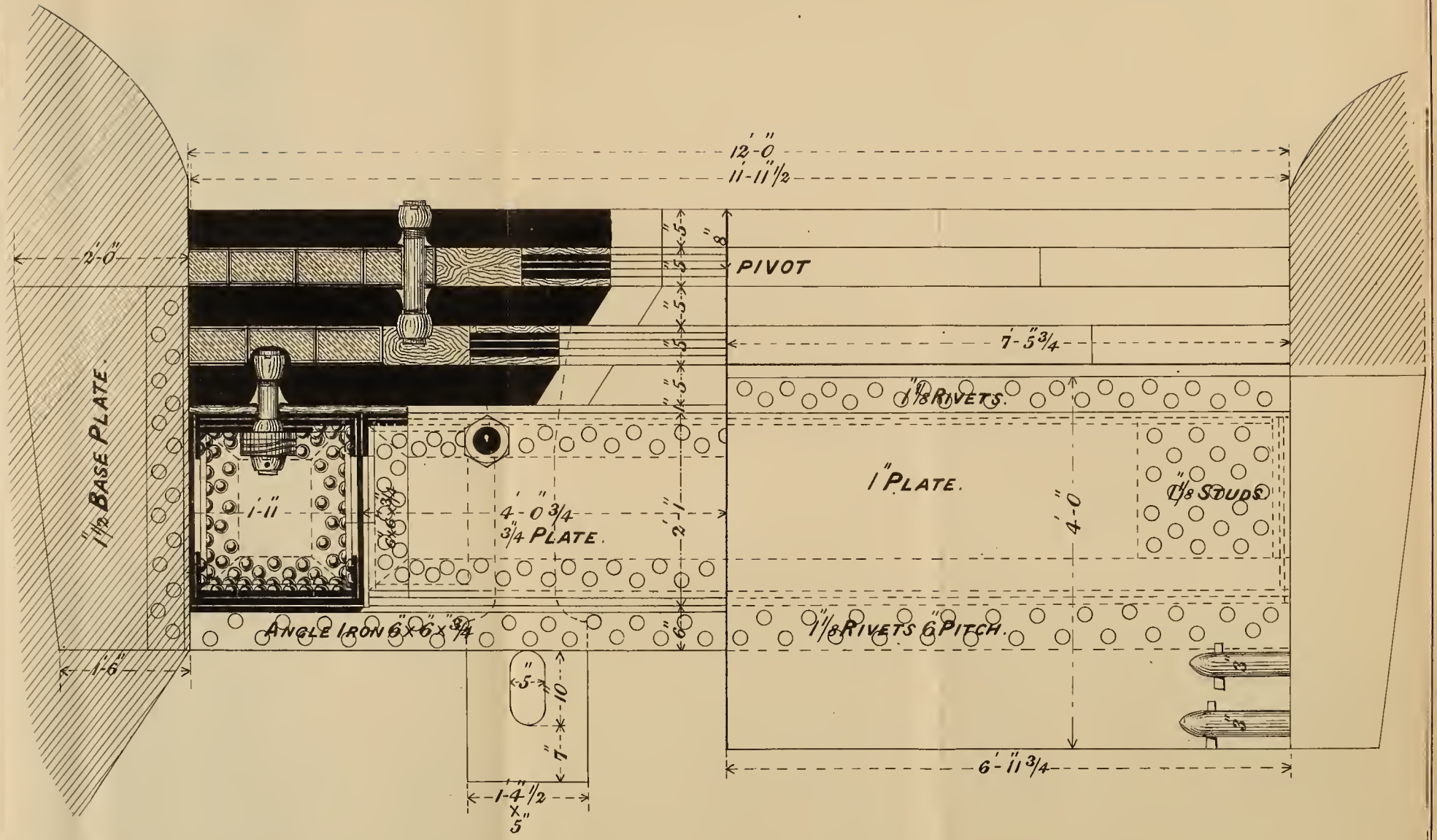
Name of station and battery.	Nature of iron protection.	Description of Guns.				
		7 in. 7 tn.	9 in. 12tn	10in 18tn	11in 25tn	12½ in. 38-ton
Malta. Abercrombie's Bastion	Shields. Three 5-in. plates, and frames 1′ 7½″ deep.	...	...	2		
Malta. Do., do.	Shields. One 4-in., one 5½-in., one 5-in., and one 1½-in. plates.	...	2			
Malta. St. Elmo. Ball's Curtain...	Shield. One 4-in., one 5½-in., one 5-in., and one 1½-in. plates.	...	1			
Malta. St. Elmo. Do. Bastion...	Shields. Three 5-in. plates, and frames 1′ 7½″ deep.	...	...	3		
Malta. St. Elmo. St Gregory's Bn.	Shield. Three 5-in. plates, and frames 2′ 1″ deep.	...	...	...	...	1
Malta. Valletta. St. Lazarus Bstn.	Do., do., do.	...	...	...	...	1
Malta. Valletta. St Sebastian Bn.	Shield. One 5½-in., one 5-in., one 1½-in. plates.	...	1			
Malta. Valletta. English Curtain..	Do., do., do.	...	1			
Malta. Ft. Tigné. S.E. Face	Shields. Three 5-in. plates, and frame 1′ 7½″ deep.	...	2			
Malta. Ft. Tigné. N.E. Front ...	Shields. One 4-in., one 5½-in., one 5-in., and one 1½-in. plates.	...	2			
Malta. Ft. Tigné. N.E. Face	Shields. Three 5-in. plates, and frame 1′ 7½″ deep.	...	2			
Malta. St. Angelo. No. 2 Batt.	Shields. One 5½-in., one 5-in., and one 1½-in. plates.	...	3			
Malta. Ricasoli. No. 1 Bastion ..	Shield. Three 5-in. plates, and frame 2′ 1″ deep.	...	...	...	...	1
Malta. Ricasoli. No. 2 "	Do., do., do., 1′ 7½″ deep.	...	...	2		
Malta. Ricasoli. No. 3 " ...	Shields. One 4-in., one 5½-in., one 5-in., and one 1½-in. plates.	...	...	2		
Malta. Ricasoli. No. 5 RD Curtn.	Shields. Three 5-in. plates, and frame 2′ 1″ deep.	...	...	...	2	
Malta. Sliema Pt. Sliema Pnt. Bat.	Curved front. Three 5-in. plates, and frame 1′ 4″ deep. Guns on turntables.	...	...	...	...	2
Malta. Sliema Pt. Do.	Shields. Three 5-in. plates, and frame 1′ 7½″ deep.	...	...	2		
Malta. St. Lucien Fort.....	Shields. Three 5-in. plates, and frame 1′ 7½″ deep.	...	...	3		
Malta. Delimara Fort	Shields. Two 9-in. plates, and frame 1′ 10″ deep; prepared for third plate.	...	...	...	...	6
Gibraltar. Montague Bastion	Shields. One 4-in., one 5½-in., one 5-in., and one 1½-in. plates.	...	...	3		
Gibraltar. Orange "	Do., do., do.	...	...	2		
Gibraltar. King's "	Do., do., do.	...	...	4		
Gibraltar. South "	Do., do., do.	...	...	3		
Gibraltar. Victoria "	Do., do., do.	...	...	2		
Gibraltar. New Mole	Shields. Three 5-in. plates, and frame 1′ 7½″ deep.	...	4			
Gibraltar. Alexandra Battery	Curved front. Three 6-in. plates, and frame 1′ 10″ deep. Guns on turntables.	...	...	...	...	1
Gibraltar. King's Bastion	Do., do., do.	...	...	...	...	1
Gibraltar. Wellington Front.....	Curved front. Two 9-in. plates; prepared for third plate; frame 1′ 10″ deep. Guns on turntables.	...	...	...	...	1
Gibraltar. Prince Albert Battery.....	Do., do., do.	...	...	...	...	1
Gibraltar. Engineer " ...	Shield. One 4-in., one 5½-in., one 5-in., and one 1½-in. plates.	...	...	1		
Gibraltar. 9th Rosia "	Do., do., do.	...	...	3		
Halifax. Fort Charlotte	Shields. Three 5-in. plates, and frame 1′ 7½″ deep.	...	...	4		
Halifax. Ives Point	Do., do., do.	...	6	3		
Bermuda. Fort Cunningham	Iron front. Outer thickness 5-in. plate, second 5-in. bars, third 5-in. plate, with backing of bars 12″ deep, extra 5-in. plate at ports.	...	...	5		2
Bermuda. Alexandra Battery	Shields. One 5½-in., one 5-in., and one 1½-in. plate.	...	4			

GH.



CASEMATE SHIELD 9FEET HIGH.

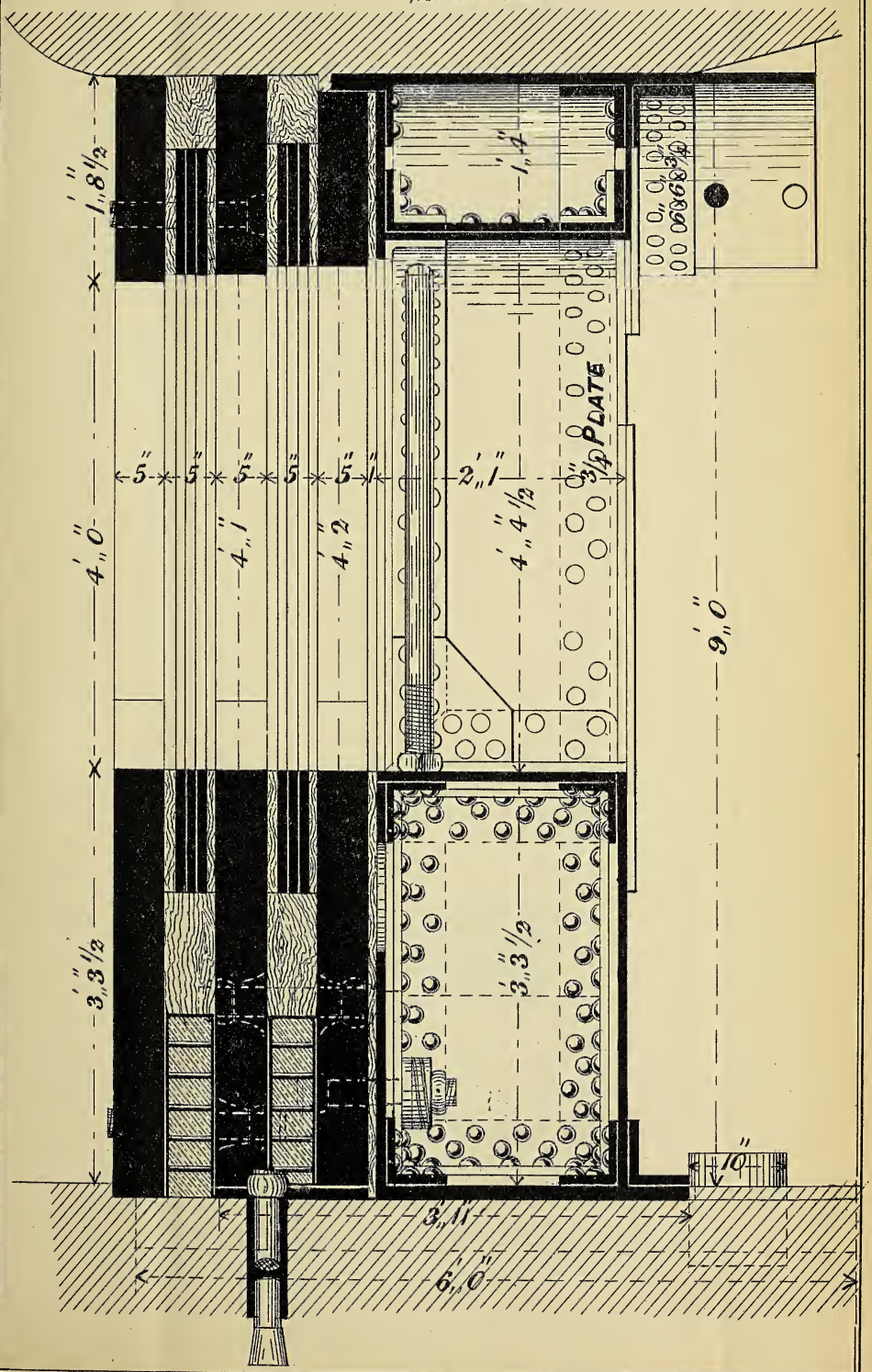
1/18 FULL SIZE.



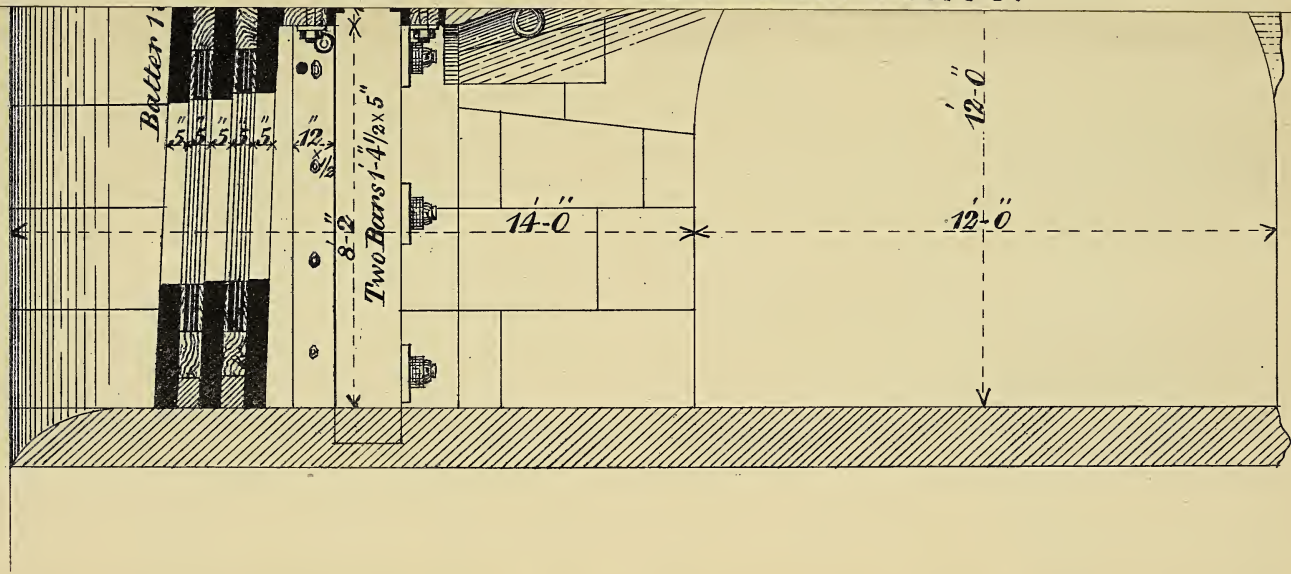
CASEMATE SHIELD 9 FEET HIGH.

PL. IV.

1/18 Full Size.

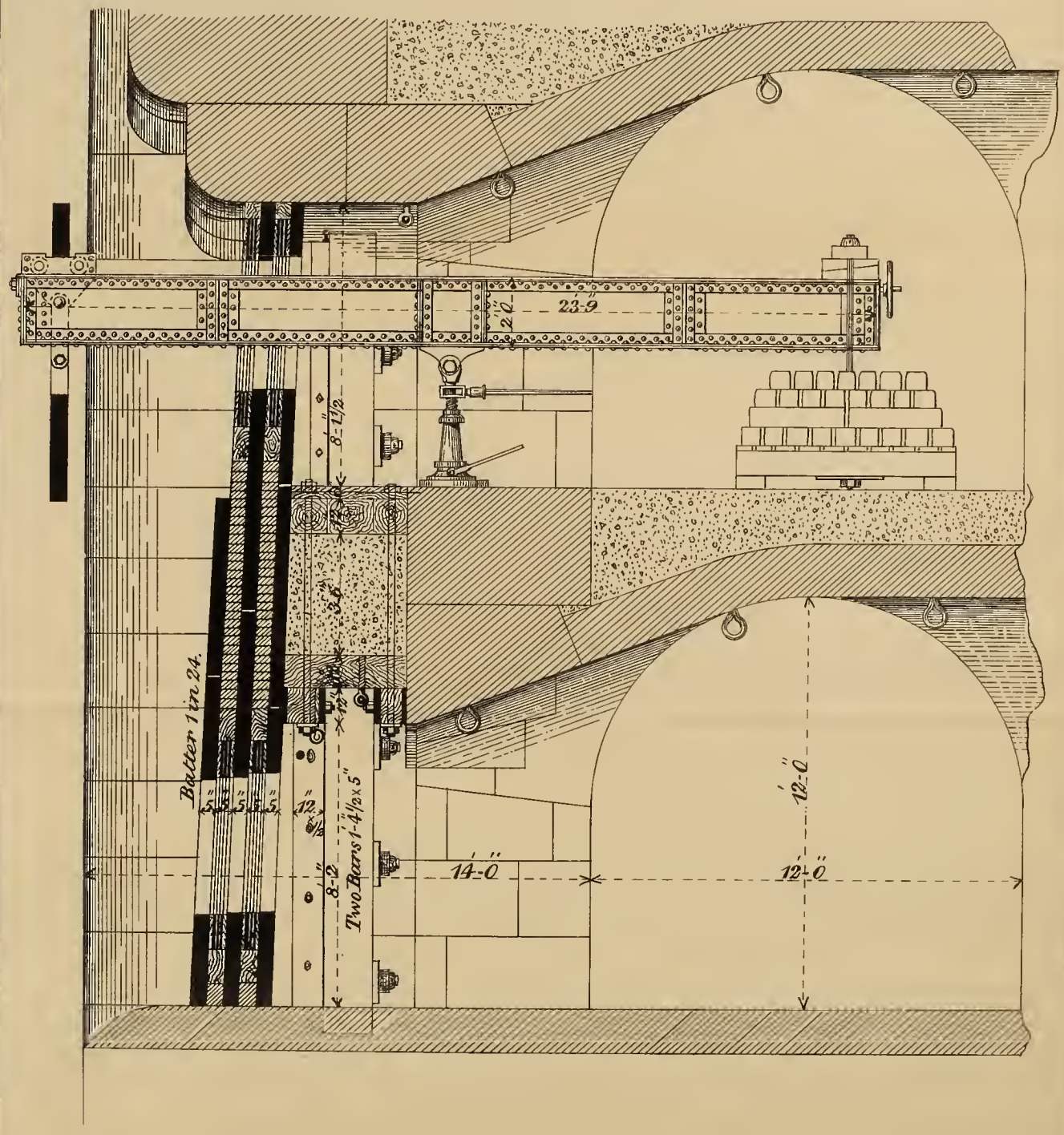


PICKLECOMBE & GARRISON POINT FORTS.



PICKLECOMBE & GARRISON POINT FORTS.

SCALE $\frac{1}{48}$ FULL SIZE.



With regard to casemate shields in masonry works, Diagrams Nos. III and IV, represent one of these, 9 ft. high, which is suitable for a 25-ton or 38-ton gun. Casemate shields described.

A smaller kind, 8 ft. high, has been used for guns below the 25-ton gun.

This type of shield consists broadly of the supporting structure, which we call the shield frame, and the armour.

The first point is to secure the frame to the masonry, so that it cannot be driven back. This is done either by extending the base and top plates into the masonry, or by the use of massive dove-tail pieces, under the frame, provided with stops. The base plates are also bolted down to the masonry.

These shield frames are made of $\frac{3}{4}$-in. plate, and 6-in. by 6-in. angle-irons, and weigh from $8\frac{1}{2}$ to 10 tons each when empty. They are filled with concrete when erected.

The armour generally consists of three thicknesses of 5-in. armour with intervals of 5 ins., filled with brickwork or concrete between them, and round the opening of the port there are strong wrought-iron frames to keep this filling in place. Between the inner plate and the shield frame there is an inch interval, usually filled with wood. Each thickness of armour is bolted to the one next behind it, and the rear plate to the shield frame. No armour bolts show in the casemate.

The weight of three thicknesses of 5-in. armour is about 25 tons, and the weight of one of the smaller of these shields complete is about 56 tons.

Some of these shields are protected by two thicknesses of 8-in. plate, and some by three; in one instance—namely, in the shields for 38-ton guns, at Garrison Point Battery, Sheerness—there are three thicknesses of 10-in. plates. Some shields have thicker armour.

There is a modification of this type of shield suited to open batteries to which over-head cover can be added at pleasure; and in more recent casemated works for 38-ton guns, as at Seaforth Battery, Liverpool, and St. Helen's Fort, off the Isle of Wight, there is another, perhaps the best arrangement of all, in which the armoured protection occupies a frontage of 20 ft. between the masonry piers. Open battery shields. Seaforth and St. Helen's shields.

The shields at Hoo and Darnet Forts, on the Medway, are of a somewhat different pattern, and the two-tier shields in Garrison Point Battery, Sheerness, and Picklecombe Battery, Plymouth Sound, are of another kind, shown in Diagram VII. Hoo and Darnett shields. Two-tiered shields.

In these shields the ports are generally cut for a lateral training of 60°, elevations up to about 10°, and depressions down to 4°, according to the circumstances of the works. Range of fire in shield ports generally.

The next kind of protection to be noticed is that given to heavy guns mounted on turntables. These occur in certain positions where an extended lateral fire of about 120° is required—as at Casemates for heavy guns on turntables.

Spithead defences, St. Helen's Fort ..... two turntables for 18-ton guns.

Gibraltar " { Prince Albert's Bastn. / King's Bastion ..... / Wellington Front ... / Alexandra Battery ... } four " " 38-ton "

Malta " ...Sliema Battery ..... two " " " "

The general arrangement is shown in Diagram No. VIII, from which it will be seen that there are two gun ports in each, and the gun being mounted on the ordinary casemate carriage and platform, fires through 60° out of each port, the turntable being used merely for transferring the gun from one port to the other.

The front protection is on much the same principle as that of the shields already described, only it is of necessity circular in plan.

The armour is usually in two thicknesses of 9-in. plate, or in three of 6-in. (at St. Helen's, and Sliema Point, batteries it is in three thicknesses of 5-in.) The roof structure is of strong girders, with arch plating between them, and carries some 6 ft. of concrete, and is thoroughly bomb-proof.

The turntable consists of a very stiff circular platform, varying from 20 ft. to 23 ft. in diameter, and strong enough to bear the weight and shock of the gun in any position of training.

It revolves on a set of conical rollers running in a live ring, and is held in position by a central spindle which passes into a massive casting. The table is turned by hand-gear, working into cogs on its outer rim. It is locked by a set of tumbler stops when the gun is in position for firing.

The larger-sized turntable weighs about 37 tons. It can be lifted bodily, without dismounting the gun, for purposes of inspection and cleaning.

It is proposed that the guns on these turntables should be turned to the the rear for loading, where there will be every facility for the operation.

Sea forts. I now come to the sea forts, the batteries of which as I have said early in this paper, are protected by walls composed wholly of iron.

These are the following :—

Plymouth Breakwater Fort. Plymouth Breakwater Fort. This iron battery is oval in form, 144 ft. long and 114 ft. broad, and stands about 100 yds. behind the central part of the Breakwater (the floor being about 16 ft. above high water mark), on a mass of masonry resting on a rocky bed about six fathoms below low water mark. It will mount fourteen 38-ton guns, and four 18-ton guns, firing through small ports, (21 ft. 9 ins. from centre to centre). The iron-work was commenced in 1867, and finished in 1870.

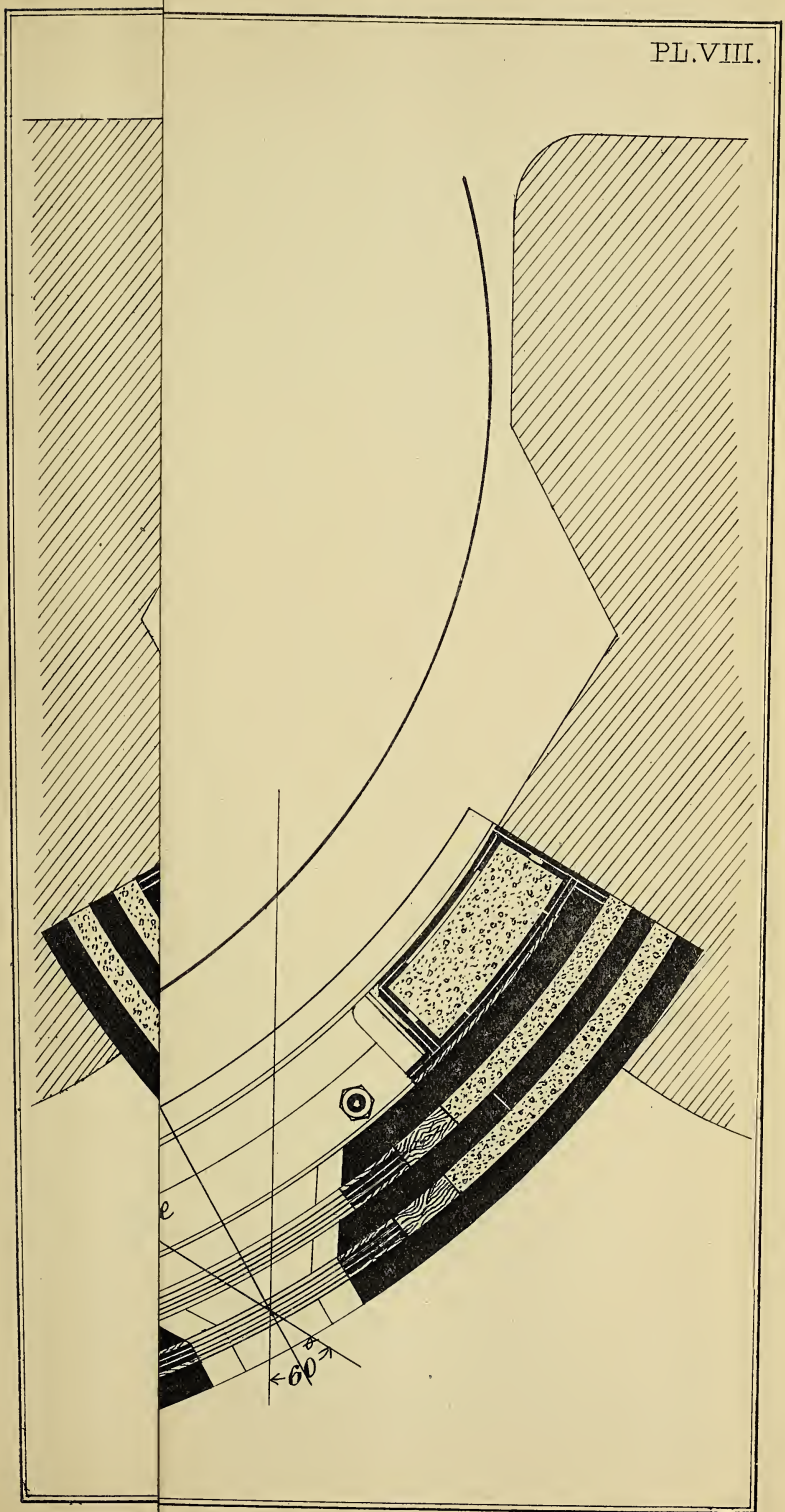
I shall not stop to describe this work further than to say that there are four thicknesses of 5-in. armour about the port, and three thicknesses supported by massive armour bars on edge elsewhere. The piers supporting the roof structure are separate from the armoured wall. The roof is of the usual girder construction, and bomb-proof throughout.

There is to this, and to all the other sea forts, an entrance port into which, in preparing for action, a massive armoured shield on wheels is run, and over the entrance is a very strong cantilever beam for hoisting the guns and other heavy weights from vessels into the battery, and *vice versâ*, by means of heavy hoisting gear placed on the roof.

I do not give a diagram of this fort, because the general principles of our armoured structures are better illustrated in some of the other forts.

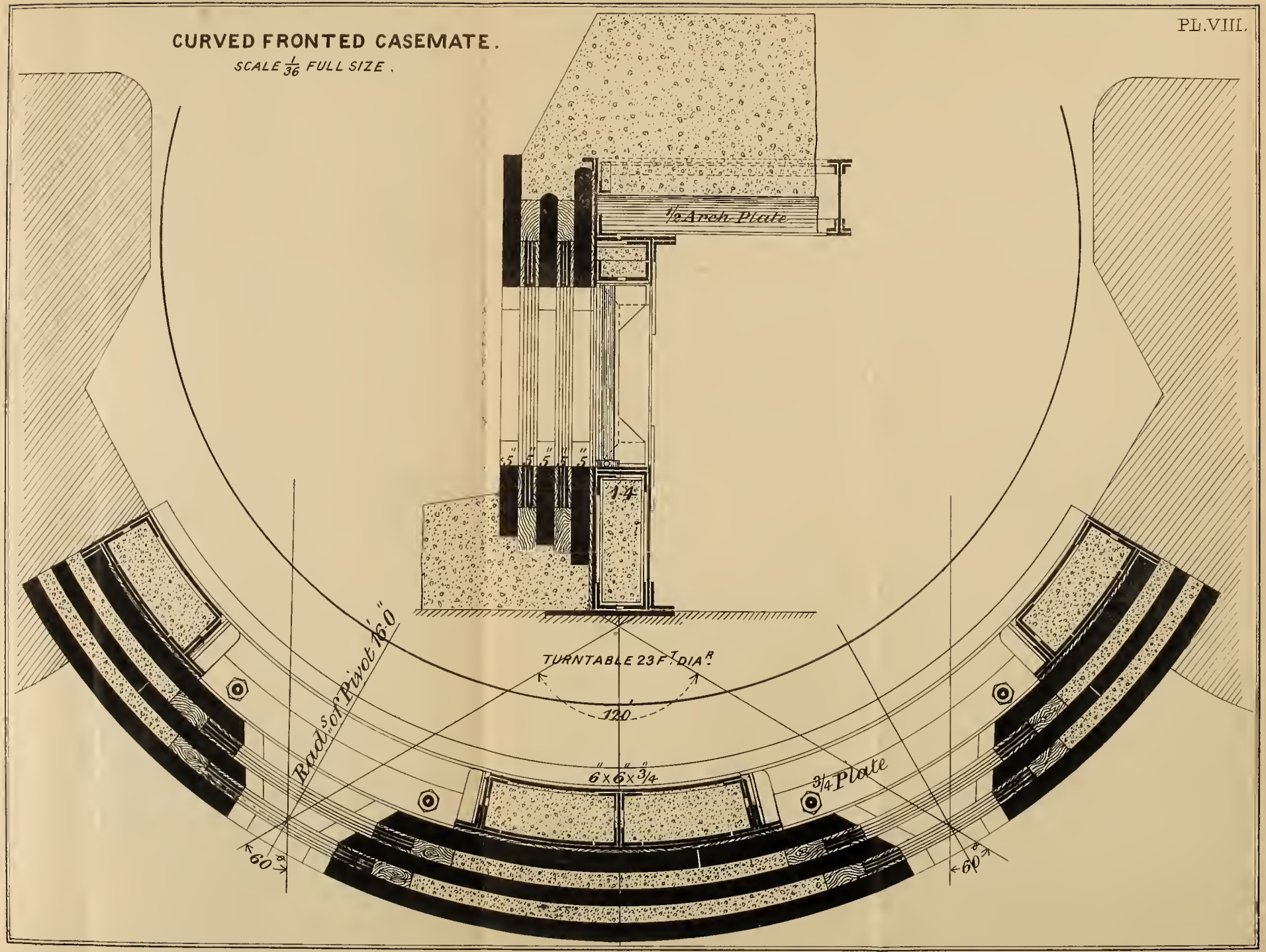
Fort Cunningham, Bermuda. It may be mentioned here that there is another iron battery of this type at Fort Cunningham, Bermuda, constructed about the same time as the Plymouth Fort, only it has straight instead of curved faces ; it has also small ports for two 38-ton and five 18-ton guns.

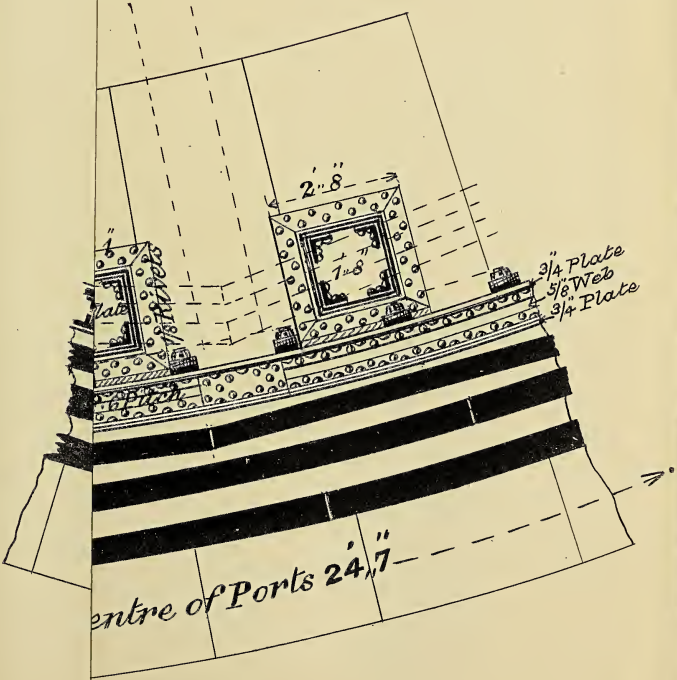
Portland Breakwater Fort. The next kind of iron battery is that represented by Portland Breakwater Fort. (See Diagrams IX. and X.)


e
60°

CURVED FRONTED CASEMATE.

SCALE $\frac{1}{36}$ FULL SIZE.

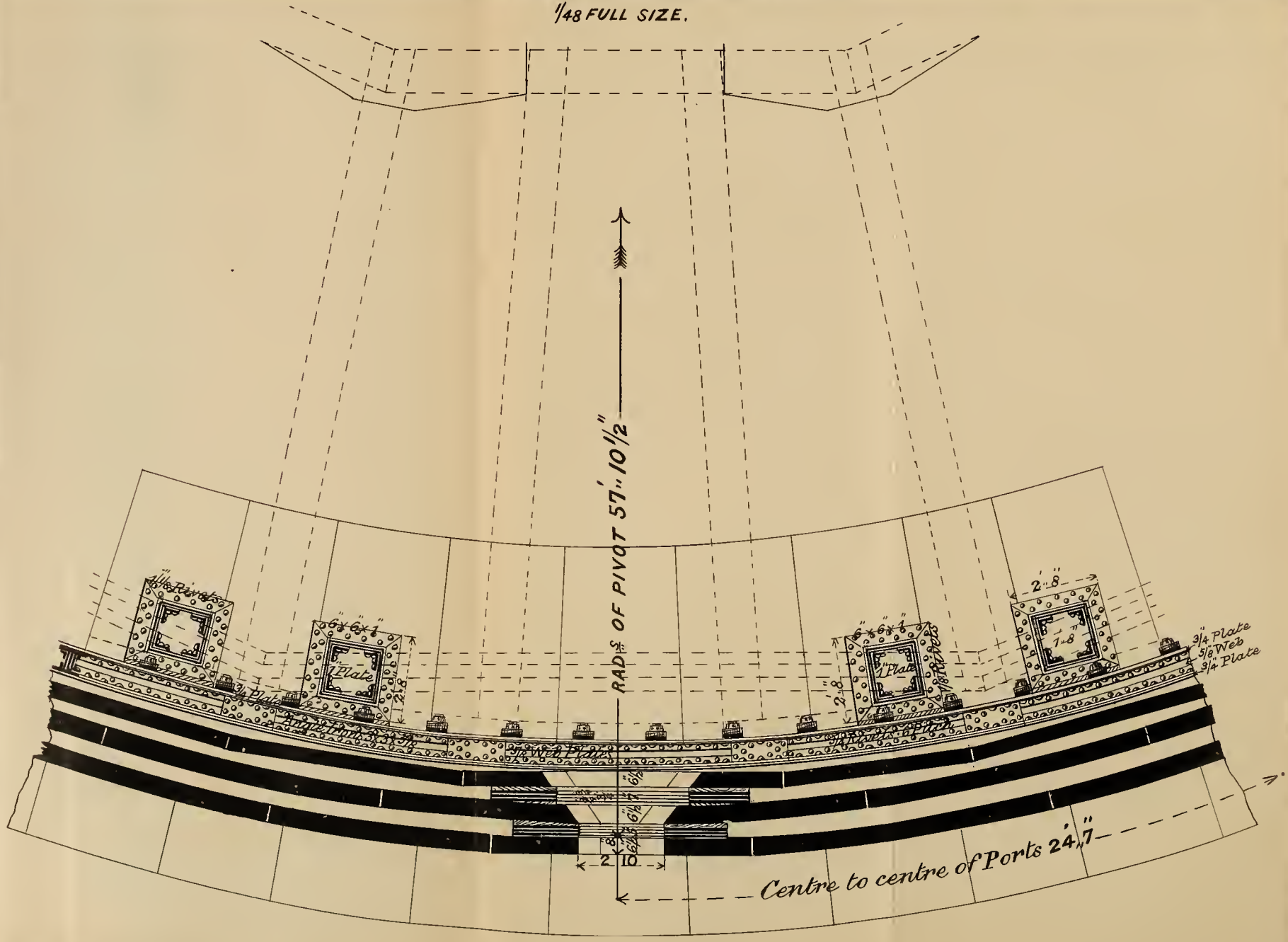



2'-8"
1'-8"
3/4 Plate
5/8 Web
3/4 Plate
Centre of Ports 24'-7"

PORTLAND BREAKWATER FORT.

PL. IX.

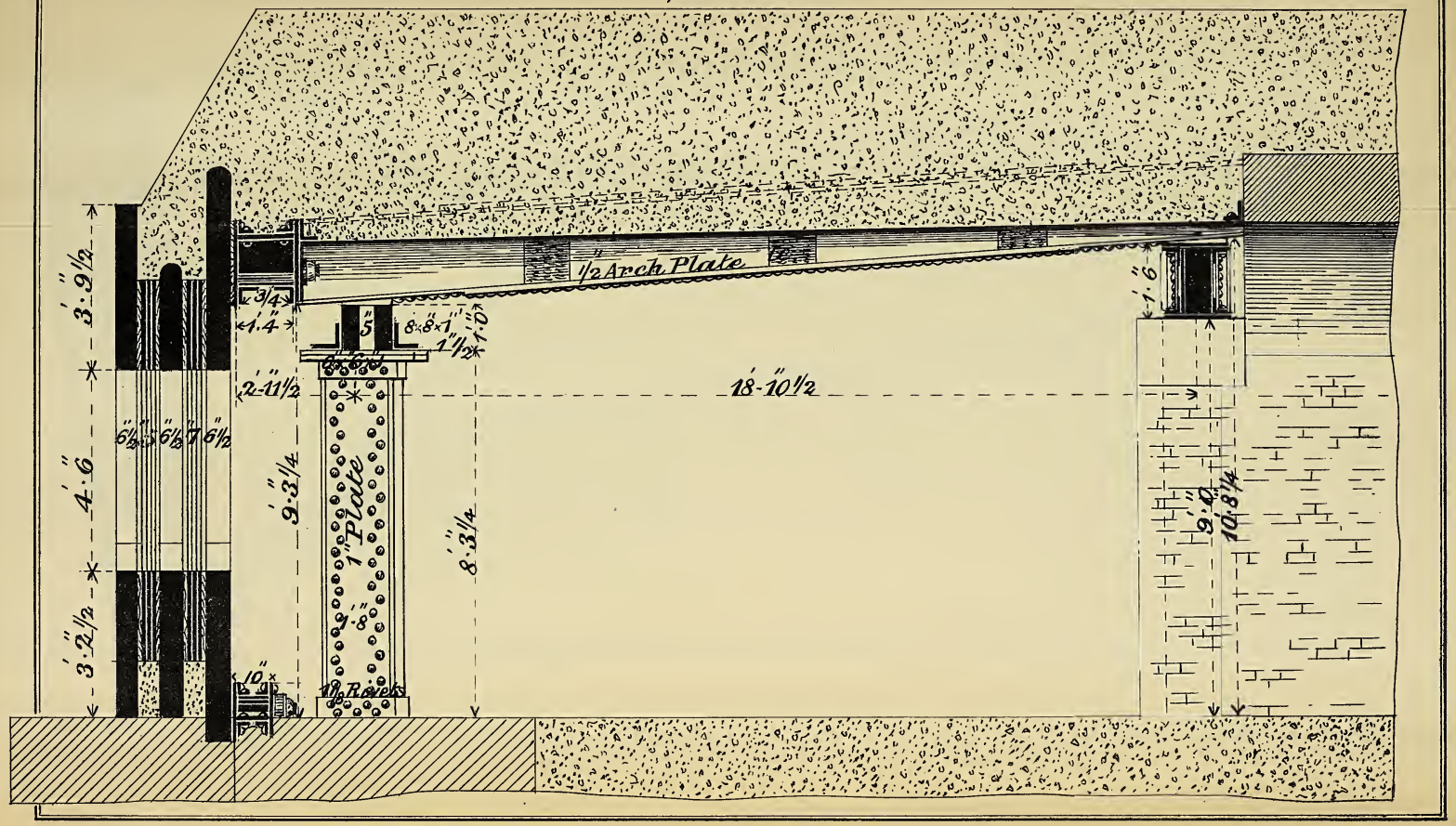
1/48 FULL SIZE.

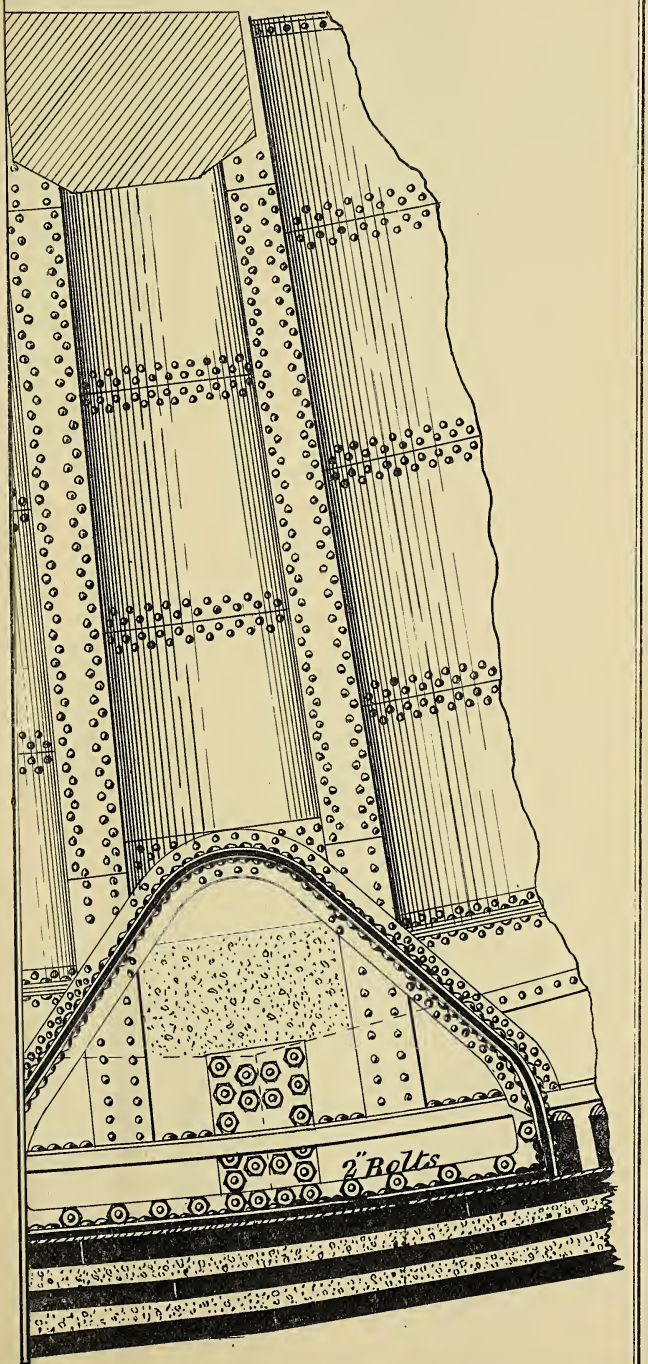


PORTLAND BREAKWATER FORT.

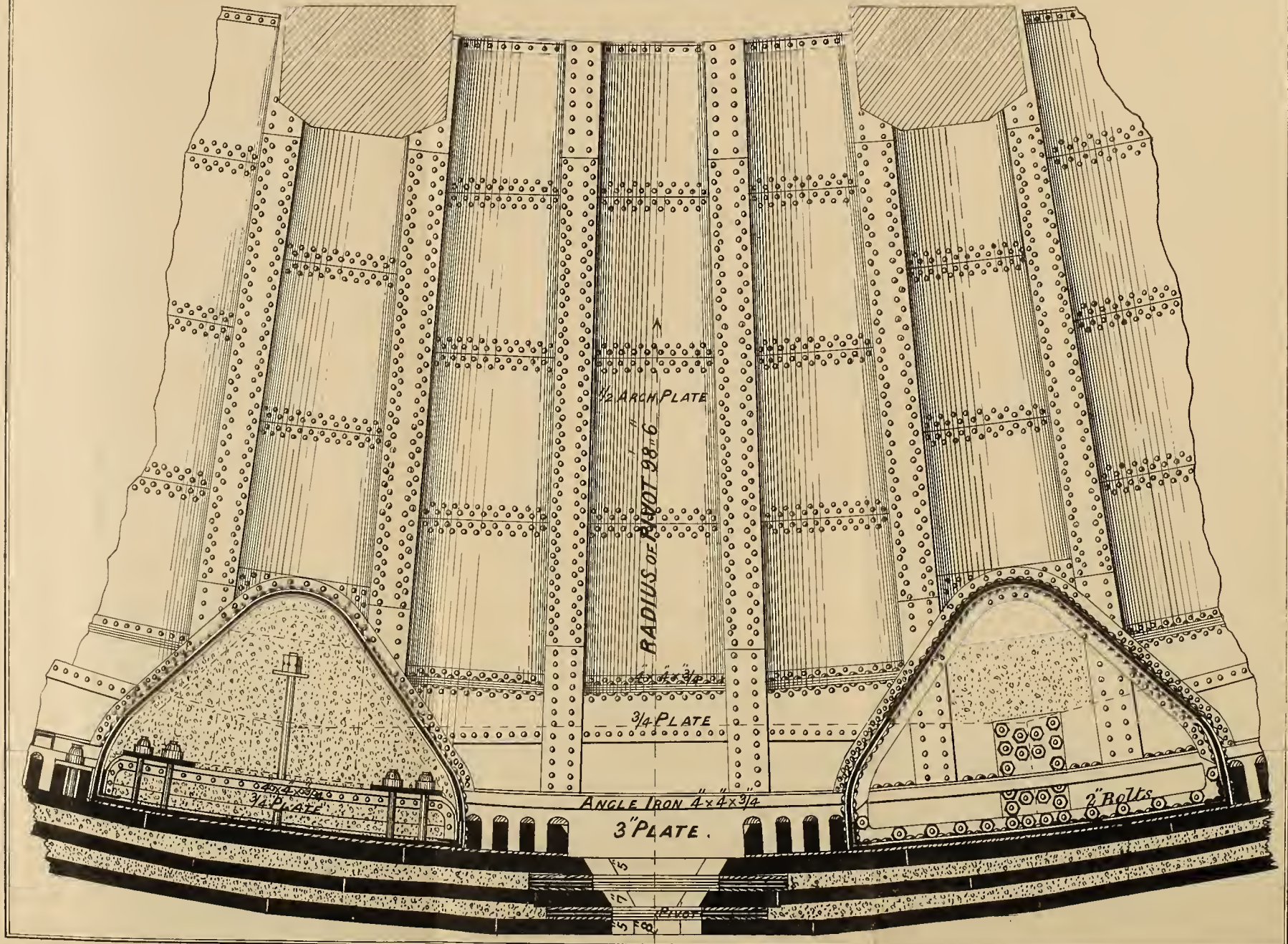
1/48 FULL SIZE.

PL. X.

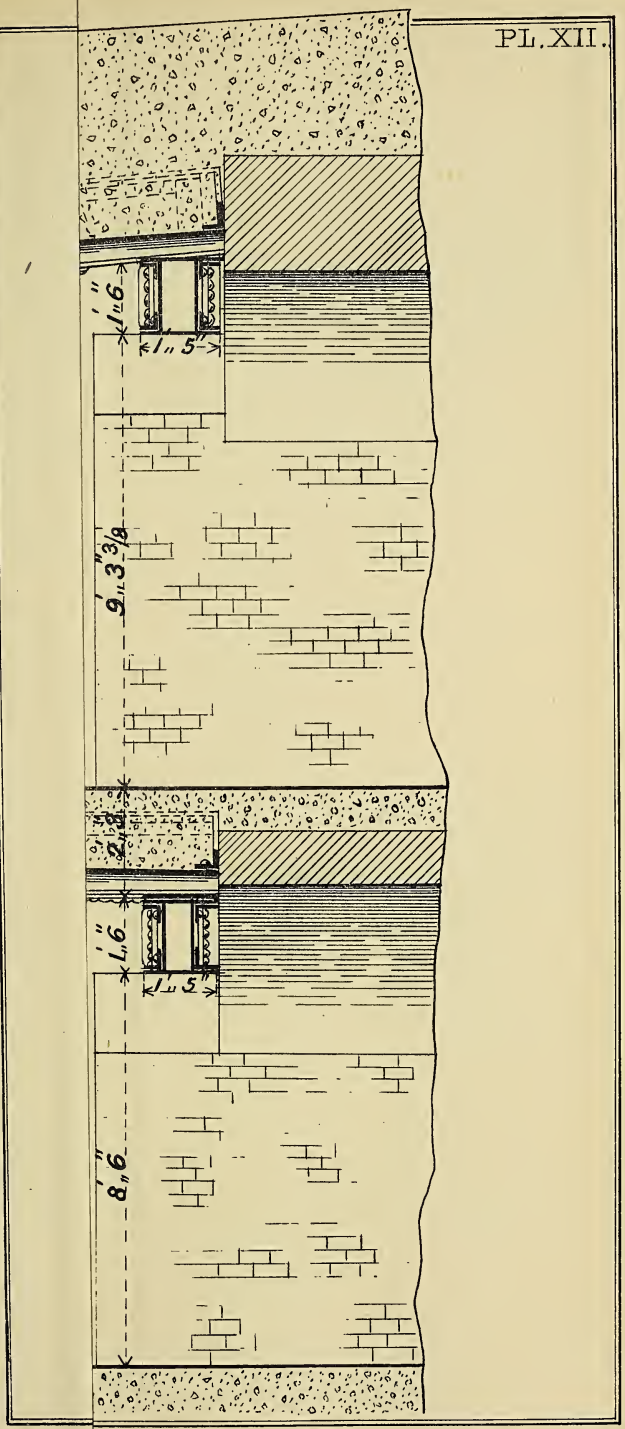



2" Bolts

HORSE SAND & NO MANS LAND FORTS.



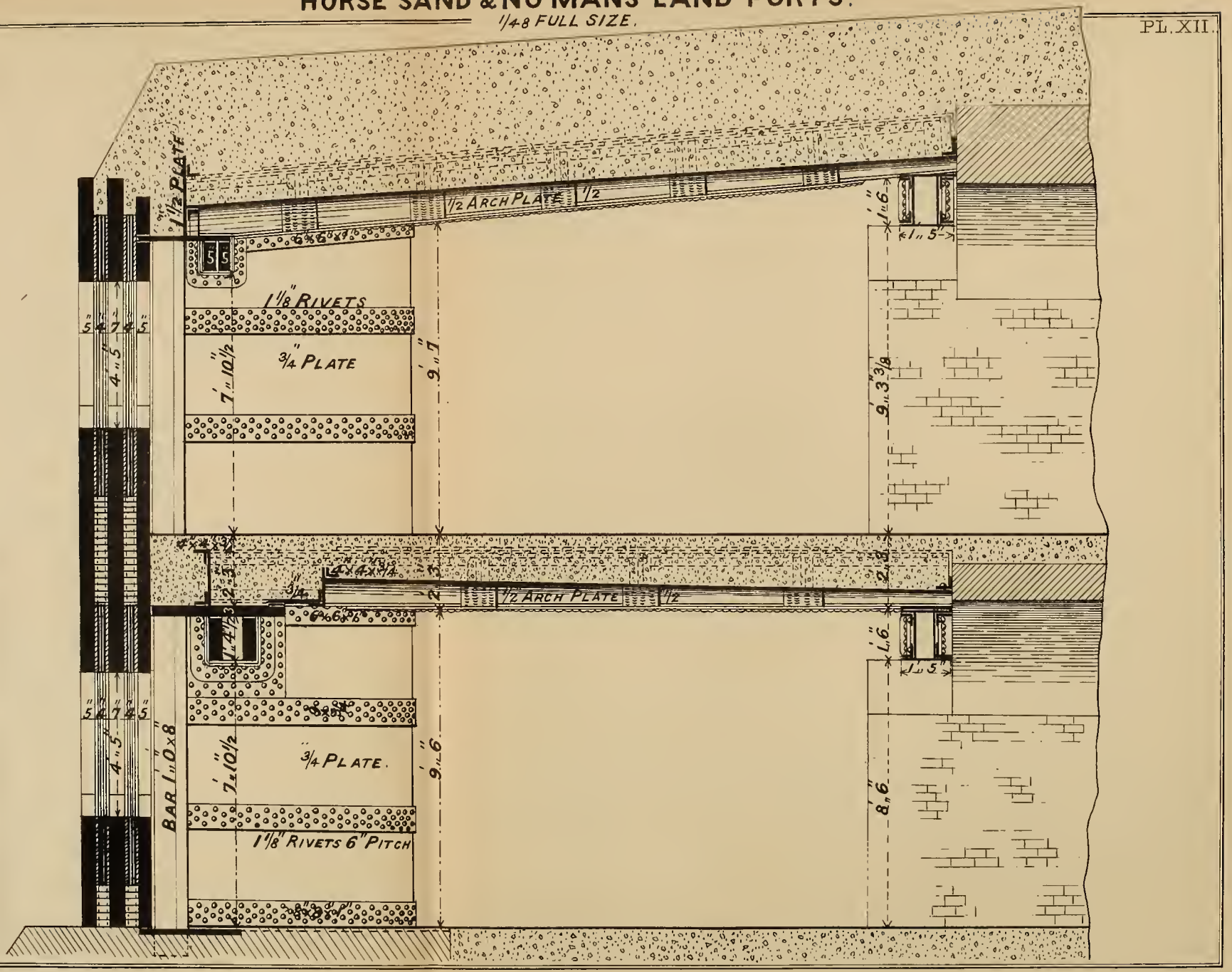
PL. XII.



HORSE SAND & NO MANS LAND FORTS.

1/48 FULL SIZE.

PL. XII.



This fort occupies a site at the end of the Breakwater at Portland. Its foundations rest on a clay bottom about 10 fathoms below low water mark. The battery is circular (radius about 58 ft.), and its floor is about 23 ft. above high water mark. It is to mount fourteen 38-ton guns. The gun ports are 23 ft. 4 ins. from centre to centre.

With regard first to the inner structure and roof of the battery, this consists, generally speaking, of two strong rings of box-girder construction going all round the battery, one at the level of the floor, and the other at the level of the roof, against which the armoured wall rests. The remainder of the inner or supporting structure consists of strong iron pillars, in couples, between the ports, which carry a ring of solid armour bars round the entire battery to form the front support of a bomb-proof iron roof. The rear of this roof is supported on a ring of box-girders resting on masonry piers.

The armoured wall consists of three thicknesses of 6½-in. plates, with port frames, 2¼ ins. thick, round the ports.

Spitbank Fort.

Spitbank Fort, which is the innermost of the Spithead Forts, is of similar construction to Portland Breakwater Fort, except as to form and size.

The iron battery mounts nine 38-ton guns, and occupies the outer or seaward side of a fort of about 150 ft. in diameter, the rest of the fort being of masonry. The battery floor is about 16 ft. above high-water, and in all respects the construction of the Portland Fort applies to this, except that the armoured wall here consists of only three thicknesses of 5-in. plate, which are prepared to receive a fourth when necessary. The iron work of this battery was completed in 1875.

Horse Sand and No Man's Land Fort.

The next works to be described are the two great forts at Spithead, standing on either side of the main channel, about 2000 yds. apart. (See Diagrams XI. and XII.) They are named from the shoals on which they stand.

Their foundations were laid some two or three fathoms below low water, and occupy circles of about 230 ft. diameter. The masonry work is carried up to a height of about 16 ft. above high water, and at that level commences the two-tier circular iron battery for 24 guns on the lower floor, and 25 guns on the upper. As hitherto intended these were to be all 38-ton (12½-in.) guns below, and 18-ton (10-in.) guns above, but it is more than probable that in each tier some of these will be superseded by the new type of long, more powerful, and more suitable, breech-loading guns.

The two forts are almost identically the same in dimensions and construction. They are circular, to a radius of 100 ft., and the gun ports are either 24 or 26 ft. apart.

Treating each as composed of an inner structure, and an armoured wall, as in the other forts, the former—or skeleton, as we got to call it in the course of erection—consists of the following parts:—

First there is a circular base plate 2 ins. thick, and about 3 ft. wide, sunk into the masonry, and going completely round the fort. In this base are slotted large holes to take the feet of upright armour bars which back the armour plates in front of the guns.

Next come the lower pier casings, 11 ft. 9 ins. and 12 ft. 9 ins. by

7 ft. 6 ins., made of $\frac{3}{4}$-in. plate, very strongly put together, and filled with concrete. Into the upper parts of these piers are set the ends of solid bars, which have to carry a part of the load of the floor above.

Next above these lower piers is a ring of 3-in. plate going all round the fort. It is slotted with holes, and the upright bar supports, already mentioned, are threaded through them.

On this 3-in. plate the front ends of the radial girders of the upper gun floor rest. Their rear ends are carried by box girders bearing on the masonry piers of the fort. Between the radial girders are the arch plates, which complete the floor.

The front ends of these floor girders are secured to a continuous curved plate standing on edge.

It is to be particularly observed that no part of this floor structure is fastened to the 3-in. plate of which I have been speaking. It merely rests on it, and the surfaces are free to slide if necessary. The object of this provision is that if the front armoured wall should be heavily battered, the risk of the racers of the upper guns being thrown out of position thereby should be reduced to a minimum.

The construction of the parts of the skeleton which intervene between the lower and upper piers demanded especial care, as these partake of necessity of the character of a joint, and it was of the utmost importance that this joint should not be a rickety one.

The construction of the piers and framework of the upper tier is, generally speaking, a repetition of that of the lower casemates, except as regards a few particulars which I need not mention here.

The armour bar supports are in one length from the lower floor to the roof, where they pass through another continuous ring $1\frac{1}{2}$ ins. thick.

The pier casings are filled from top to bottom with Portland cement concrete.

The safe load of the upper gun floor, and of the roof, is equal to a mass of concrete 10 ft. thick laid all over it, which is equal to half a ton on every square foot.

Next, with regard to the armoured wall. This, it will be seen, is in three thicknesses. The inner ring is all 5 ins. thick, and there is 1 in. of wood and Portland cement between it and the skeleton structure. It consists of two tiers of plates and two rings of armour bars, and is bolted to the inner structure and to the piers. The frames round the ports are $2\frac{1}{4}$ ins. thick, and are exactly like those at the Portland Fort.

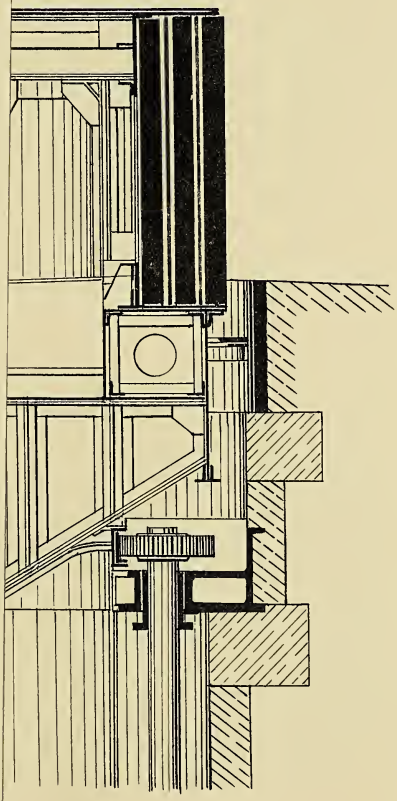
The plates of the next or middle thickness all stand on their ends, and are 22 ft. 6 ins. long, reaching from the granite base to the level of the roof. The plates in which the ports are formed are 7 ins. thick (each weighs 18 tons) the rest are 5 ins. thick. This thickness is bolted to the inner plates. The plates in the outer thickness are all 5 ins. thick, and are in two tiers of about 11 ft. each. They are bolted to the middle plates. The intervals between the armour plates are filled with concrete except at the port frames, where there is wood.

At the level of the top of the lower front plates there is a gallery all round the outside of the fort.

The weight of iron work in each of these forts is as follows:—

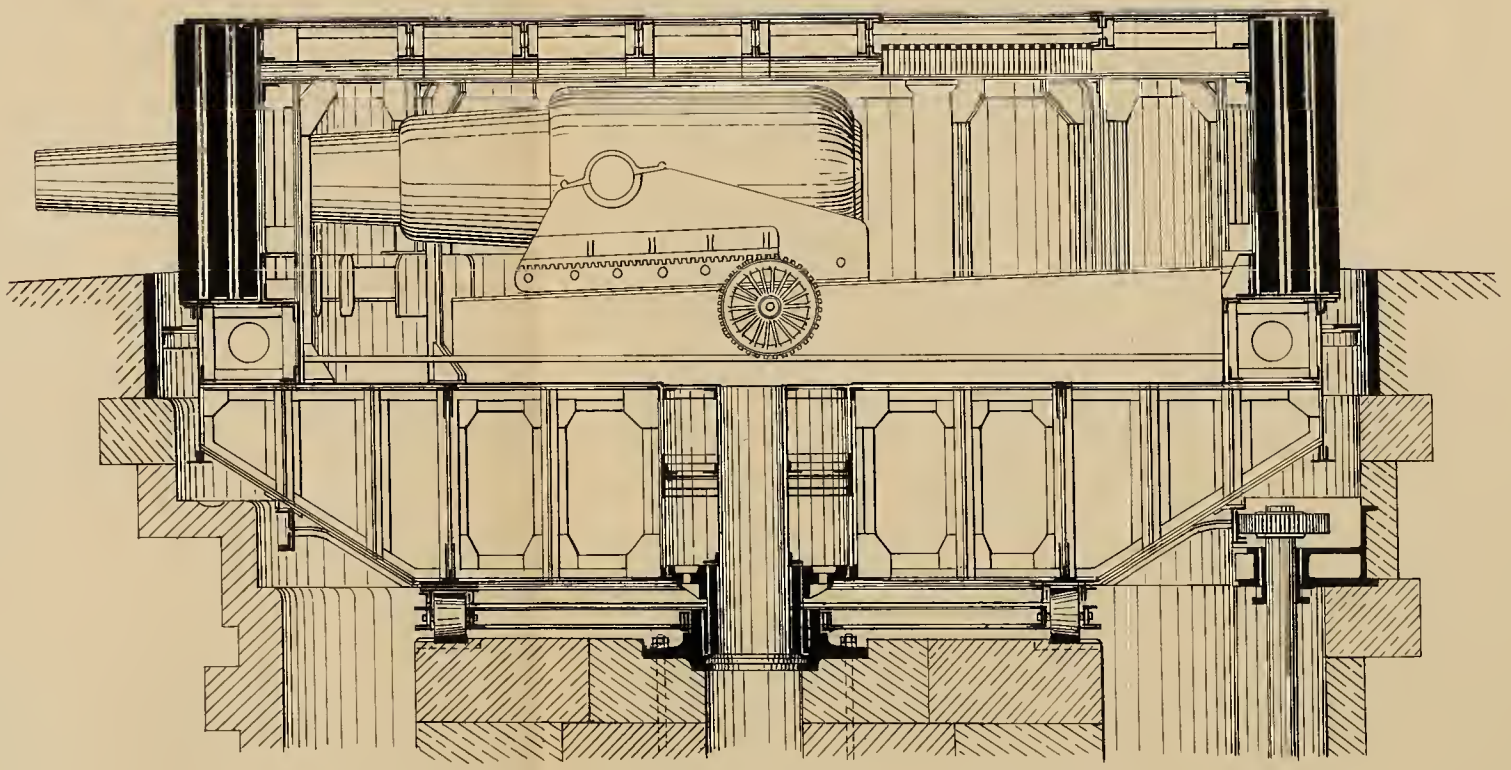
		Tons.	Tons.	Total.
Skeleton.....	per gun	50 =	2450	6214
Armoured wall.....	"	75 =	3764	

ER PIER.



TURRET FOR TWO 80 TON GUNS AT END OF DOVER PIER.

SCALE 1/72 FULL SIZE.



Strengthening plates will probably be provided for the lower batteries of these forts so soon as any number of ships of foreign powers shall be armed with guns equal in power, say, to our 80-ton and 100-ton guns. The masonry on which these batteries stand will then require a corresponding addition of strength, for which provision was made originally by leaving an offset on which armour plates can rest, and holes have been formed in the masonry for armour bolts.

Turrets on sea forts.

Each of these sea forts at Spithead, Spitbank, and Plymouth is prepared for the addition hereafter of turrets on their roofs to carry two of the heaviest ordnance in each. The Spithead forts to have five turrets each, the others two each.

Mantlets.

Every gun mounted behind iron protection is to have a suitable mantlet made of rope-work for the three-fold object of deadening the effect of vibration caused by shot blows on the exterior, of stopping splinters driven off from the iron itself and bullets and fragments that may enter the port, and of keeping out smoke.

As hemp rope is liable to catch fire on the discharge of the gun, it is washed with a solution of chloride of calcium, which renders it completely uninflammable. Professor Abel helped us with his valuable advice on this point.

Turret on Dover Pier.

I have now come to the last of the works to be described—namely, the turret, for two 80-ton guns, now on the point of completion, at the extremity of the Admiralty Pier at Dover. (Diagram XIII.)

The work to carry this turret consists of an enlargement of the outer end of the pier, as at present completed. The foundations are laid at a depth of about 7 fathoms below low water mark, and the guns will be at a level of about 33 ft. above high water. The structure, therefore, from the bed of the sea to the guns is about 95 ft. high.

Speaking in general terms, the turret consists first of a live ring, and rollers of steel running on a path of steel laid on a massive cylinder of masonry. On this live ring runs a structure of iron framework of the form shown in the diagram, weighing about 240 tons. This framework contains the gun chamber, which is protected by three thicknesses of 7-in. armour, with two intermediate thicknesses of 2-in. plates, making together a weight of about 460 tons. If to these weights be added that of the guns, carriages, and the slides on which they will stand, the total running weight will be about 895 tons. This will throw upon each of the 32 rollers of the live ring a pressure due to about 28 tons. The outside diameter of the turret is 37 ft., its internal diameter is 32 ft., the interior height of the gun chamber is 8 ft. 8 ins., the height of the turret armour is 9 ft.

It will be seen that a massive central casting is first held firmly down to the masonry, and that inside this there is a thick cylinder of hammered Bessemer steel surrounding the built-up wrought-iron cylinder, which forms the centre of the turret framework. I draw attention to this part, because, of course, the shock of blows on the turret walls, or more strictly speaking the unabsorbed part of it, ultimately comes to this part, and it has received especial consideration on that account. The framework is generally of wrought-iron.

The roof of the turret is of strong splinter-proof construction. Over

each gun there is a part of it which is removable, to admit of its being got in and out, and a part is made of open bars to allow a current of air to clear off any smoke that may enter the turret. The gun ports admit of 7° of elevation, and 2° of depression; the turret is capable of all round fire. The glacis outside the turret is supported by a ring of armour plates on edge, 5 ins. and 3 ins. thick, on a strong circle of 2-in. plating. The muzzles of the guns are brought inside the turret and depressed to an angle of 14°, for loading, which will be done under the glacis by steam gear, but into the arrangements for that I shall not here enter.

The turret is turned by a pinion, the vertical shaft shown working into a large ring with steel trundles, secured to the framework, the power being given by a set of main engines capable of working up to 300 h.p., and auxiliary engines of 45 or 50 h.p. For the working and loading of the guns there will be another engine of about 30 h.p.

All the engines and the boilers are in the lower part of the battery some 30 ft. below the guns. The magazines are at nearly the same level as the engines, and the shell stores at a higher level.

There will be a system of communication, by signal and speaking, from the gun chamber to the engine room, and throughout the battery.

Concluding remarks.

The period during which the works, which are here described, have been carried on has been one of continual transition and change—I might say of revolution—in the affairs of artillery, more sweeping, I suppose, than anything that has taken place since the days in which gunpowder was first invented; and to my mind, there is nothing in the present aspect of affairs to justify us in fancying that this unsettled period is near its end.

It is easy to conceive that this at any rate has not lessened the difficulties of those who have had to deal with these works. Sometimes forts have been designed, and more than half-built, when an entire change of armament and of the character of defence has been decided upon. Works intended for one class of gun have had to be adapted to one of three and four times its power, and all other conditions have frequently been affected in a corresponding degree.

At almost every step hitherto taken those who have been engaged in designing and carrying out these great works have received the valuable advice and assistance of many of the most able officers of the Royal Artillery, and I must also especially refer to the great advantages that we have had in being closely associated, for experimental purposes and for the testing of armour, with the officers of the experimental staff of the School of Gunnery at Shoeburyness, under successive Commandants.

As regards coast defence both at home and abroad, I believe there is a great field yet before us, and I am certain that the more intimately the Royal Artillery and Royal Engineers are associated in these matters, the higher will be the standard of efficiency attained, and the greater will be the success.

ITALIAN PERCUSSION FUZE (1879) FOR FIELD AND MOUNTAIN GUNS,

(*Mittheilungen über Gegenstände des Artillerie-und-Genie-Wesens.*)

TRANSLATED BY

CAPT. G. C. WYNNE, R.A.

This fuze was introduced in December 1879, to replace the percussion fuze of 1877, for B.L. field and mountain guns.

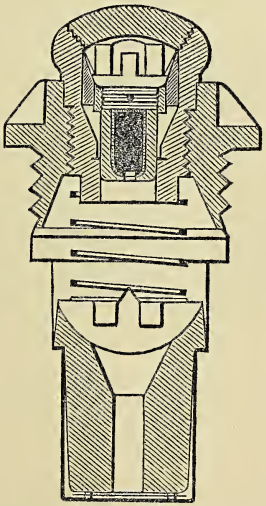
It consists of four chief parts—

I. The outer case.

II. Cylindrical box, screwed into upper part of body, and which contains the case with detonator.

III. Spiral stop.

IV. Weighted needle for firing detonator.



I. The upper part of the outer case has a screw, cut outside, for fixing into shell, and one inside to take the cylindrical box. The lower part is a cylinder of sheet-brass, to contain the weighted needle.

Through the bottom is pierced a hole, over this is a disc of wax cloth, then one of thin paper, and then a disc of sheet-brass pierced with a hole, corresponding to that in the bottom of case. These discs are held together by three rivets.

II. The cylindrical box is of brass; it is bored axially, but its interior diameter is not the same throughout. It is screwed into the upper part of outer case, and, is itself closed by a screw stopper. In the upper part of it, where its diameter is greatest, is a ledge, on which is placed a ring, on which rest four feathers supporting the case containing the detonator. At that point of change of the diameter of the interior which is nearest the bottom of the box, a leaden ring is fixed in a groove, cut to receive it.

III. The spiral stop is a helix of rough brass wire, which supports the weighted needle, during the time of flight of the shell.

IV. The detonating needle is attached to a brass cylinder which is pierced axially.

The case containing the cap with detonating composition, is of brass, having a brass screw stopper. The upper part of the case is cup-shaped, and fixed in this, by the stopper, is a ring with four feathers, on which the case is supported. At the bottom of the case is a small lead ring.

The cap composition consists of five parts of chlorate of soda, two parts of fulminate of mercury, and five parts of sulphide of antimony; of this composition, about ·28 to ·3 of a gramme is placed in a tin cap, enclosed in one of copper, which is placed in the case, so that the tin cap rests on the small lead ring. The ring with the feathers is then placed in the cup-shaped top of the case, and the stopper screwed in. Lastly, the ring for supporting the cross feathers is placed on the uppermost ledge in the cylindrical box, the case with detonator placed thereon, and the cover of the box screwed on.

The action of the fuze is as follows :—

On the shock of discharge, the feathers being bent upwards, the case containing detonator slides down and lodges on the leaden ring at the bottom of the cylindrical box, so that the cap projects through the bottom of this latter. The needle is, however, prevented from striking the cap by the spiral stop. When the shell strikes the object, the weighted needle crushes the brass helix and the fuze is fired.

(*Extract from the "Revue D'Artillerie," Sept. 1880,*)

TRANSLATED BY

CAPT. A. E. TURNER, R.H.A.

ADOPTION OF A REVOLVER FOR HORSE AND FIELD ARTILLERY IN HOLLAND.

The "*Recueil Militaire*" states, that the war minister in Holland, having come to the conclusion that the smooth-bore pistol carried by mounted men of horse and field artillery, as well as the short sword worn by dismounted men of the latter, are insufficient for their personal defence, has issued the following orders, with the sanction of the King.

1. The depôts and all the men in regiments of horse and field artillery, will be armed with the cavalry pattern six-shooter revolver (system Chamelot-Delvigne) :—

Calibre		9·4 mm = ·37 in.
Weight of	cartridge	16 gram. = 9 drams.
	ball	12·2 gram. = 7 drams.
	charge	·6 gram. = 9·2 grains.

2. The revolver will be carried in a holster, attached to the right side of the waist-belt, and, in addition, will be slung to a cord, passing through a ring on the end of the butt; this will be worn round the neck, in front of which it will be drawn together, by means of a keeper, so that it will fall over the centre of the breast. This cord will be red for the field, and yellow for the horse artillery.

3. The ammunition will be carried in the wallets for mounted men, and in a small-arm ammunition box, which will accompany the gun, for dismounted men.

4. In order that the men, in cases of emergency, may be able at once to lay their hands upon some rounds of ammunition, a small pocket will be made in the inside of the skirt of the tunic on the right side, for men of the field artillery; while in the case of horse artillery the present pattern pouch will be slightly altered for the purpose.

5. The pouch will therefore be withdrawn as an article of equipment for field artillery.

6. The present pattern holsters will also be altered so as to carry the revolver, in order that the men may not be under the necessity of carrying the same, except at times when there is immediate prospect of its being required.

NEW SIGHT FOR VETTERLI RIFLE IN ITALY.

A new sight has been brought forward for the Vetterli rifle, which will give the elevation up to a range of 1600 metres (about 1733 yds.) Some trials made with it, by the 1st Regiment of Grenadiers, have proved it to be both simple and effective. Its adjustment is exceedingly easy, and truer than that of the ordinary sight. Two kinds of notches have been tried, one V-shaped, the other spherical, but no difference has been perceived in the results obtained from their respective use.

LETTER

ON THE

WELDON RANGE-FINDER,

FROM

MAJOR J. B. RICHARDSON, R.A.

St. Thomas Mount, Madras,
October 4, 1880.

My Dear Sir—

I forward to-day, by parcel post, as a present to the Institution, a complete set of Weldon's Range-Finders, consisting of two angle-finding and one auxiliary base-finding instrument.

These instruments have been made up, out here, at a cost of Rs. 10 per instrument, or under £3 for the three. I mention this to give an idea of what their probable cost will be. I fancy that in England they will be much cheaper if made in any quantity, but Major Weldon has patented his inventions, and I have great difficulty in obtaining a supply of instruments from him, though, since I wrote a paper on the subject (No. 1, Vol. XI.) in the "Proceedings," many officers have written to me to try and get them a set of instruments.

As the instruments leave here they are in perfect adjustment, but should the journey derange them, I shall be glad if you will let me know. I have, purposely, not taken any great care in packing.

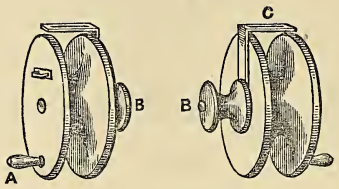
Two of the instruments read the same angle. The other (that with the long glasses) is the "Auxiliary Base Glass." I have painted "base glass" on its under side in white.

The paper I have above quoted will give a rough idea of the use of the instruments, but it was written before I had the experience of its use which I now possess. In my battery, for a year-and-a-half, no other range-finder has been in use, and I have generally instructed all my range-finding N.-C.-O's. myself, so that it seems to me a few further notes on its use may be interesting to any officers who may take an interest in improved range-finding, and who may make a trial of the instruments I send. Perhaps you would let any such see this letter.

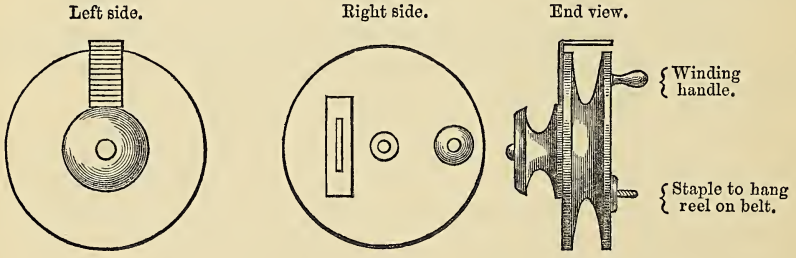
To work with the instruments, some further articles are required. They are such as any battery artificers can make.

1st. A reel, capable of holding at least 150 yds. of fine twine. I

do not think the reels we use very good, but, in default of better, we use a similiar description to those of Major Weldon. In these the



reel itself turns. The left hand grasps the large handle *B*, the right hand winds up by the small stud *A*, the iron guider *C* being fixed to the large handle *B*, does not revolve with the reel, and it guides the twine into its place on the reel. The reel should be about 6 ins. in diameter, and only hollowed out just sufficiently to allow 150 yds. to fit easily into the hollow. The lighter the wood the better, provided it doesn't chip easily. I should think beech would do well.



The measuring twine passes through a slot cut in the top of the iron guider, the slot being made just as broad as the reel. The twine used is extremely thin, and is, I believe, technically known as saddler's twine, but of this I am not sure. It stretches a little at first, and is then not reliable, but the more it is used, the less it stretches, whether wet or dry, and, when long in use, becomes very fairly reliable. The line is marked with small pieces of parchment cut thus—

Real size.

The line is ended by a leather strap just broad enough to pass through the slot in the guider. It has a hook at the end capable of

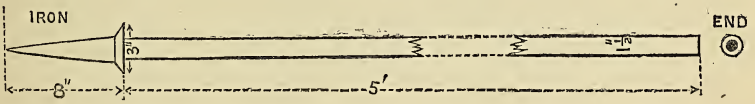
hooking into a hole in itself. Measurement begins from the centre of this strap when doubled. Every 5 yds. one of the parchment marks is

attached with a lever-hitch, and each yard is marked by a little scrap of red (or other) wool sewn on by fine thread. Practically, until we get an old line, we do not add the red marks, it would be too much trouble to alter them often; the parchment marks are easily altered. These marks are numbered from 1 upwards. Each represents 100 yds. of range—thus

reads 2000 yds.

reads 1500 yds., and each red mark reads 20 yds. The strap is to put over the pole I am about to describe. I am particular in describing each thing used as, since we began, we have been constantly altering, and nothing has been done without a reason generally too long to describe.

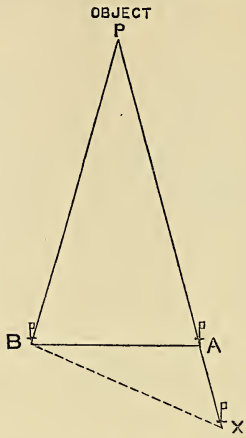
At least two strong poles should be made (three are better) somewhat of the following dimensions, light and strong. The iron shoe and



rim enables the stick to be fixed in the ground readily, using the foot on the rim. In the end of the stick a hole is bored just large enough to receive the handle of an instrument.

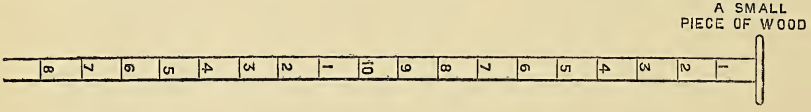
The screws on the glasses are to enable the instruments to be adjusted. This requires a little knack. At this place we have a carefully measured base, with points marked over which the glasses are placed, and it takes a very short time to adjust errors. Once adjusted correctly they very seldom vary, even with very rough handling, but it is found that a first adjustment of a new instrument is seldom correct, for the screws give a little. I doubt if you will find the glasses I send appreciably out, but change of climate may affect them, and we have so little change of temperature here that I have no experience on that point. I should be slow to alter them. If both agree exactly it is unlikely they have altered much, and, unless the eye is practised, it is apt to imagine its own faults are those of the glasses. The easiest way to get a base of adjustment is to use a theodolite, taking every care to adjust it properly. Take a known distance from a good map (say from one of the vanes on the Academy to some marked point on the Barrack Field), set off an $\angle$ of 88° 34′ 3″, measure along the base $\frac{1}{20}$th of the known distance. On each of the points set up perpendicularly one of the sticks, and on each stick place an instrument, then in each instrument (if in adjustment) will be seen the image of the distant object coinciding with the centre of the opposite instrument. If out of adjustment, take out with a small screw-driver the outer screw of the brass guard which covers the three adjusting screws, and adjust the angle of the glasses by loosening and tightening the centre and two outer screws alternately, but taking care to *leave* them all tight. I have said there is a knack in doing this, and if not properly done it will be found that a little rough usage, such as dropping the instrument a few times, will alter the adjustment. When well adjusted it is not very easy to put the glasses out.

To test the auxiliary base glass:—Having got your other two



glasses on these poles—accurately laid—find some point X where the object P can be seen through the open shutter of A's glass, and where the glass of B is seen reflected along the same line, then AX should $= \frac{1}{5}$ of AB, or $\frac{1}{100}$ the range. This glass requires careful adjustment. With it ranges may be taken considerably under a minute.

For the auxiliary base we have, so far, made shift with a reel somewhat similar to the one I have described, but not so broad, and of greater diameter, capable of holding a tape 40 yds. long. This is marked every yard in red, and again every 10 yds. in black, thus—



Every yard represents 100 yds. range, the black figures representing tens of yards. Three men should use the instruments when the auxiliary base glass is used. The auxiliary base-finder gives the end of the tape to the angle-finder, and runs off to the latter's left until he gets the angle-finder's glass and the object in line, moving right or left as required. The angle-finder holds the end of the tape in the same hand as he holds the glass, while the auxiliary base-finder lets the tape slip through his hands until he gets the reflection of the glass of the distant base-finder and the object seen through the angle-finder's shutter to coincide. This, with practice, can be done while the angle-finder and base-finder are finding the range, but it needs great accuracy, careful training, and very much practice—so much so that men at first are *never* correct, particularly on a moving object. When the angle-finder calls out "correct" the auxiliary base-finder looks at his tape and reads off the range.

In this country it is very difficult to get satisfactory work from tradesmen, and I have made the tapes myself for the auxiliary base-finder, by

painting ordinary tape with two or three coats of flake white (oil), and then painting the ranges on them in black and red, but such tapes are not strong, though they do not stretch. In England a good tape of the kind needed could easily, I suppose, be obtained, and this would simplify the working greatly. The narrower the better, consistent with strength, as wind catches a broad tape.

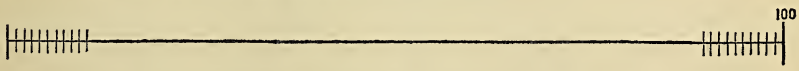
Another great disadvantage here is the fact that it is too hot to take a squad out except early in the morning, or late in the evening, for little over an hour at a time. The light is generally very bad, and before the men have got well to work it is too hot to go on. In England I could, I think, train reasonably intelligent men to work correctly with the auxiliary base-finder in a fortnight. Here I would not trust their results under a month or more, but much depends on eyesight, intelligence, and a habit of correctness. Some men will always try to fudge; they often think the range they have obtained *must* be incorrect, and instead of giving the exact result they have obtained, shorten or lengthen the range. Frequently the range they have really obtained is perfectly correct. Such men I draft out of a squad—they are useless. A good way of finding them out is to make them pace yards. Count yourself the paces they take. It is impossible that they should always be correct, but some men think it smart to be so, and add or subtract a yard or so with great effrontery.

Four men are as many as one instructor can readily train at a time. I should like to caution those who make trial of the range-finder against the belief that they will at once, without any practice, find ranges both accurately or quickly. Some men never do either, some learn very rapidly, but of the men I have trained there are only a few on whom I could rely to within 20 yds. of a range.

In the following instances I have taken the results of a squad of young N.-C.-O's. It is now three weeks since they commenced, and I have taken the instances at random, or rather have taken them from out of a great many records, with a view to point out particular instances—not to show accuracy. It is a very good practice to invariably record all the work done. I wish I had done so from the first; it would have given me a far better notion of the men I could depend upon.

My system of training, which is capable of great improvement, but has answered fairly, is worth a trial.

To begin with, pacing is quicker than measuring, and if a man can be got to pace yards nearly correctly, a range is generally found accurate enough for artillery practice to commence. If great accuracy be required the base must be measured.



I, therefore, measure out 100 yds., and mark each yard for say ten yards at each end of the measured distance. The men pace this 100 yds. walking at their natural pace, the result being recorded. Then they pace up and down the marked yards until they get into a yard

stride, and I then send them down the 100 yds., recording the result. They do this daily, and the result is recorded, and I gather from the record which men I can rely on. I find a man whose natural pace varies little generally is most correct in pacing yards, while tall men who may naturally pace longer than a yard require most practice before they become reliable.

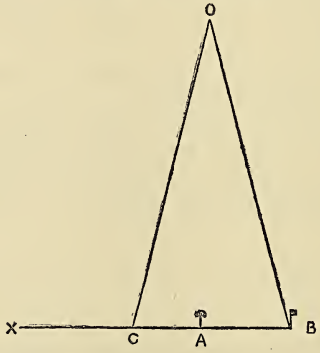
I copy a few entries to show how I record this pacing :—

Name.	Height.	Natural pace.	Pacing yds.	Natural pace.	Pacing yds.	Pacing yds.	Natural pace.	
Corp. E. ...	Short.	110	106	104	105	102	105	
Br. W. ...	Tall.	99¾	103	98	98	105	97½	
Br. C.	Short.	111	101	110	100	101	109	Good.
Br. K.....	"	112	107	110	104	101	109	
Br. H.....	"	105½	104	105	102	100½	105	Very good.

I have now several shortish men, generally driver N.-C.-O's., who on flat good ground can pace yards with very considerable accuracy. The instruction each day is commenced with this practice.

Next, in order to show the men what they are expected to do, two instruments are correctly laid at each end of a base, reflecting some well-defined object. It is explained to them that 20 times the distance between the two instruments is the range of the object, and they look in the instruments and learn how they are expected to lay.

Each man is then taught to find the range of some moderately distant object single-handed. It should at first be a very well-defined object, such as the edge of a house, &c. The man has two poles, a measuring reel, and an instrument. He presses one pole firmly into the ground, as perpendicularly as possible. *A* runs off to the right and finds any point *B*, when he sees the object, *O*, reflected along *BX*.



Then he plants another pole and runs along the line *BX* until, on turning-about, he finds some point, *C*, where the reflection of the object and *A* and *B* are all in one line. Here he makes a mark on the ground,

and proceeds to pace from *C* to *B*. The number of paces is recorded, and the man putting the loop of measuring twine over the post *B*, measures the distance *B* to *C*. This shows whether he has paced correctly or not.

The other men are meanwhile taking the same range from nearly the same spot, and thus the results are checked. I generally record the result somewhat as follows :—

Sept. 21st. Early morning; rather dark, but clear.

Name.	Time.			Range.		Error.
	Commenced.	Ended.	Total mins.	Paced.	Measured.	
Br. W. ...	5.46	5.48¼	2¼	2025	1990	+ 35
A.-B. C. ...	5.48	5.50	2	1970	1960	+ 10
Corp. E....	5.52	5.53¾	1¾	1980	1965	+ 15

The time entered does not include subsequent measurement, only the pacing.

Next, the men are worked double-handed. I record their work thus—

Sept. 27th. Commenced 5.30 a.m. Very dull and dark.

Object: Man riding at a walk.

Name.	Position.	Time.			Range.	
		Commenced.	Ended.	Total mins.	Paced.	Measured.
Br. H.....	∠	5.50	5.50½	½*	1260	1280
Br. K.....	*B*					
Man halted by signal.						
Tested by—						
Br. W. ...	...	...	...	...	1260	1290
Br. C.....	...	...	...	...		
Real range ascertained to be						1297

* Time of moving objects taken only till signal "correct" is given, and does not include pacing.

When well advanced towards correctness the men are taught to use the auxiliary base glass. Here so small a distance as an inch is of importance, and great accuracy is required. It is therefore not worth using until men are well trained. Its work should be simultaneous with the other range-finders.

The auxiliary base-finder man gives the angle-finder man the end of

his tape, which the latter holds close to his glass. The auxiliary base-finder man sees the distant object direct through the open shutter of the angle-finder man's glass, (while he holds the tape in the same hand as he holds his own.) He moves backwards or forwards until he sees the distant object direct through the angle-finder's shutter, and the reflection of the base-finder man's glass in one line, and he follows the movements of the two other men for this purpose. On the angle-finder saying "correct" he reads off the range marked on the tape.

I record work with the three glasses as follows:—

October, 1880. Man on horseback, walking.

Object: Helmet. Fair light.

Name.	Position.	Time.			Results obtained by.	Range.
		Commenced.	Ended.	Total.		
Br. K.....	∠ F.	6.15	6.16	1	Aux. Base.	810
Br. W. ...	B. F.				Pacing.	800
Br. H.....	A.B.F.				Measured.	825
Same man halted on signal, but moved some 3 lengths.						
Range for accuracy						795

In these lessons, each man has a pole, and plants it when "correct," to enable measurement to be tested.

If anybody using the glasses will take pains to record the result of his work just as he finds it, without attempting to correct errors (which at first occur very frequently), he will soon notice a great improvement in his work.

Three men work the range-finder when out with the battery, but so far the auxiliary base-finder has not been very satisfactory, for the man who uses the auxiliary base glass generally finds his horse a nuisance to him, and he also frequently finds the angle-finder's horse in his line of sight, but I hope to get over this as we gain experience. Two men work very quickly, but sometimes their horses check them in pacing the base, and it is perhaps nearly as quick to make the third man a horse holder. I have tried different plans. First of all the three men galloped out, numbered 1, 2, 3. 1 = angle-finder, 2 base-finder, 3 horse holder. 1 and 2 dismount, give their horses to 3, and take the range in the usual way, either pacing or measuring the base. This, if the base is at all a long one, takes some two minutes generally.

Then I tried two men alone. They gallop out; have the object pointed out; agree on the exact spot of the object they mean to take. No. 1 dismounts, 2 turns his horse to the left, looks through his

glass, and notes some object which coincides with the reflection of the object. He then gallops on that line rather further than he believes the base will prove, dismounts, finds the base, and having given the signal "correct"—by raising his arm—paces towards No. 1, who also paces towards 2. They meet, add their paces, and call out the range. This, if the base is long, is very quick compared with the first plan—a base of over 100 yds. being sometimes done under the minute—but occasionally, as I have said, the horses check the men, particularly if there are many flies about.

With the auxiliary base-finding glass the three men gallop to about the spot where the battery will come into action. No. 1 is angle-finder, No. 2 base-finder, No. 3 auxiliary base-finder.

No. 2 proceeds as in the last, after moving some 40 yds. to front. Nos. 1 and 3 dismount, No. 3 gives the end of his tape to No. 1, who walks towards the object, 40 yds. This prevents No. 3 being so much hampered with his own horse. They find the range. No. 3 reads it off on tape, winds it up, and all three gallop in, unless the battery has arrived on the spot. This is very quick if all goes well, and it has the great advantage of allowing the battery to come into action without any measuring operations going on in front. But so far, chiefly I think owing to the inferior tapes we have to work with, it has not been a great success. The men dare not strain the tape, and the reel we use is not good for this work, it ought to be some sort of stop reel. If we could obtain a strong spring reel, which would wind up of itself on a stop being pressed, I think the auxiliary base would be a capital plan.

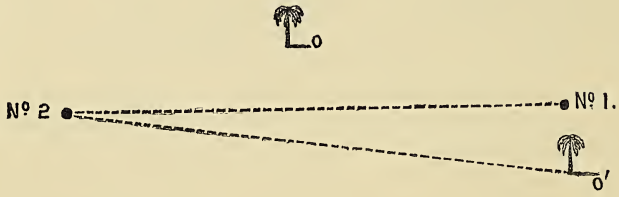
We have been amused with Edwards' papers on the Weldon Range-Finder. He forgets that they have been a good deal used, and were invented long ago. He has practically adopted Weldon's patent. His notion of an auxiliary base has been tried, but is quite impracticable from the difficulty in getting one man to align another correctly. In the auxiliary base used by Major Weldon, the man aligns himself. He asserts that such instruments as Weldon's do not measure angles with sufficient accuracy for an artillery range-finder, but they have been so used by batteries, and found sufficiently correct. Very good practice on very ill-defined objects has been made, and it would be well to make enquiries before making strong assertions.

His description of the action of a prism is entirely new. That it is practically incorrect is proved by one of Major Weldon's prisms, which works at both ends of a base. It was, therefore, hardly worth while to point out that one base angle must be half the apex angle, for the angles of this prism are not as he describes. Perhaps there is some peculiar property in the prisms of Major Weldon which prevents a ray being deflected after the fashion of Edwards' figure, but I think if any

prism be taken it will be found to act very much as Major Weldon's prism, which has equal base angles as Edwards' infers, but has *not* an apex angle of about $90\frac{1}{2}$. Furthermore, an instrument maker has been found who offers to grind angles to an accuracy of 1″, and who offered to do so for 25 francs instead of £30.

Edwards' is quite right about my description of the duplex mirror arrangement. I made a careless, but very obvious error in saying the mirrors are inclined to one another at 88° 34′ 3″. A glance at the instrument would prove this, and I fancy no one could be misled by such an obvious inaccuracy.

Edwards', again, is quite wrong in his last para., and a glance at his figure proves it. If the reflection of the object falls to the right of No. 1, No. 2 would have to retire. I have not yet found a man I have been instructing who did not at once, on seeing the reflection of the



object, *O*, in the position *O′*, state that he saw the object to the "right of No. 1." He has then to retire. I did not say on No. 1's right—and I preferred to use the simpler expression, as it is one in constant use of the men under instruction.

I remain,

Yours very truly,

JOHN B. RICHARDSON.

ON THE RANK, POST, AND DUTY OF AN OFFICER COMMANDING ROYAL ARTILLERY IN THE FIELD.

BY

COLONEL W. J. WILLIAMS, R.H.A., C.B.

In Afghanistan, where the enemy bring all arms against us, the organisation of our forces has taken the form of the mixed division. The mixed division does not enter into our army corps organisation: we have that otherwise planned. We form a division of infantry, more like a brigade in strength; we take away the cavalry brigade, leaving only a regiment, and making a cavalry brigade for the corps; and we make divisional and corps artillery, doing this, merely because others do it, or that we are slightly tinged with the old-fashioned idea of keeping some guns back for an opportunity or a crisis. Corps artillery is an unnecessary division of artillery command, and therefore an unnecessary weakening of artillery power; and, sooner or later, all the artillery will be massed with the divisions. Meanwhile, we know how a mixed division works in the field; and we need not go beyond the mixed division in considering the rank, post, and duty of an officer commanding Royal Artillery in the field.

Our divisions, in Afghanistan, have comprised from two to four brigades of infantry, of three or four battalions each—the lesser number of battalions in the case of the greater number of brigades; a cavalry brigade of two or three regiments, of three squadrons each; and an artillery brigade of from three to five batteries. The infantry and cavalry brigades have always been commanded by brigadier-generals: the artillery brigades have been commanded by a lieutenant-colonel or colonel without brigade rank, and the artillery commander has always been with the division general. This way of arranging for the command of the artillery is prejudicial to the interest of all artillery

officers, not conducive to the general efficiency of the artillery in the field, and unfavourable to the full development of artillery power in battle.

Our system is prejudicial to the interest of all artillery officers, because it is prejudicial to the interest of the officer commanding artillery in the field, whilst his position is the highest to which an artillery officer—as an artillery officer—can aspire. At present, a battery commander can gain distinction by maintaining the general efficiency of his battery under difficulties in the field, and, in opportunities of gaining distinction in battle, he is on a par with officers commanding battalions and cavalry regiments; moreover, an officer—especially a lieutenant-colonel without brevet rank, and who has never commanded artillery at our autumn manœuvres—for the first time commanding artillery in the field, may be proud of his position, as it seems a fine thing to command a brigade. But a battery commander does not pass from the command of his battery to the command of troops; and the services of the artillery commander on the staff can neither bring him the coveted distinction of conduct in battle, nor show what he would be if he were placed in more independent command. The artillery commander is admitted with the brigadiers of infantry and cavalry to conferences on intended operations; but, in battle, he commands in presence of the division general, whilst they really command and conduct their brigades and are identified with them. A mixed brigade is detached on some special duty: the cavalry and infantry brigadiers may expect to be detailed in their turn; but the artillery commander detaches his guns, and sees them march off, and remains with Head-Quarters, unless he likes to ask leave to accompany some friendly brigadier. It is prejudicial to the interest of all artillery officers that their career of possible distinction in battle should end with their promotion from the rank of battery commander, and that their field service in the higher position of commanding artillery should bring them only the opportunity of showing what they are as artillery staff officers at Head-Quarters.

Our system is not conducive to the general efficiency of artillery in the field, because it is not conducive to the maintenance of the authority of the commanding officer. It is not meant to be asserted that the efficiency of the batteries is not kept up to a high standard of excellence. Battery commanders are always very proud of their commands, they are very hard-working officers, and, for the most part, they have formed a good idea of their work, and learned it well; the subaltern officers of horse and field artillery are excellent, they are trained to be much with their divisions, and to be proud of their work in all its thoroughness and its smartness, and they have over other

subalterns the advantage of a distinct charge and a responsible duty. The efficiency of the batteries is well maintained by the battery officers. Nevertheless, it is better that there should be one commanding officer of the artillery and not several; and it is not well that there should be a commanding officer who cannot feel firmly maintained in his authority. A brigadier of cavalry or infantry, on taking the field, marches, bivouacs or camps, and fights with his brigade; he is always in their presence; and a complete understanding is soon established between him and his command, even if he has never seen them before. An artillery commander, taking the field with battery commanders and batteries he had never seen before, would never get hold of them: it would not be for the good of the service, at the beginning of a campaign, when it is very advisable to do everything as pleasantly as possible, that he should make any remarkable effort for himself. An artillery commander, taking the field with battery commanders whom he knows, or with batteries he has commanded in quarters, begins with a great advantage; but his absence on the staff, and his inferiority in rank to the brigadiers of cavalry and infantry, soon produce an effect unfavourable to him, and constantly tend to lessen his authority. The artillery know their own importance and see that they are inadequately represented by their commanding officer. The artillery commander is allowed to have his own courts-martial; and the commissariat take his signature for the signature of a general officer: these are concessions made in courtesy. The batteries are sometimes attached to other brigades for supply and transport. A battery goes on an expedition with some other brigade: the brigadier likes to have guns under his command, and the battery commander is treated with charming attention; returned to Head-Quarters, both brigadier and battery commander would like the battery to be attached permanently to the brigade. Whether it is that battery commanders would prefer to be artillery commanders, each in his own smaller sphere, or that they incline to where there is more authority, and especially more authoritative dealing with the commissariat, there is certainly a tendency of batteries towards the other brigades. The artillery commander has ever before him the ungrateful task of maintaining his own authority.

Our system is unfavourable to the full development of artillery power in battle, because there is no unity of command in the artillery. This want of unity is entirely attributable to the inferior rank of the artillery commander, and to his being with the Head-Quarter Staff. All command is united in the division general; but there is unity of command in the infantry and cavalry brigades, and there is no unity of command in the artillery. Granted, that the most cordial understanding between the division general and his artillery commander

leaves to be desired nothing which is possible; it is not possible that the artillery lieutenant-colonel or colonel, on the division staff, should be to the division general and staff what is the infantry or cavalry brigadier, who is away with his brigade, or who, having come up for orders, rides away to carry them out. An infantry brigadier is ordered to attack, a battery is in position to support him with an almost enfilade fire at a range of 1000 yds.; the brigadier fancies taking over the battery to his attack, and he gains his point by averring that he can carry the position with slight loss if he may take over the battery, and that if he cannot have the battery he can carry the position but with a loss which sounds alarming. A cavalry brigadier, finding himself in rear near the position of a battery which is not firing, but which had been in action there, gives the order for the battery to open fire, and the battery begins to fire with time fuzes over the division general and staff and people advancing to enter the position abandoned by the enemy. There is no unity of command in the artillery. The best first positions for the batteries, with regard to the ground and the enemy, may be taken up; but, in the course of the day, there are manœuvres to be made, changes of direction of fire, changes of position of batteries, and again changes of direction of fire. Some officers vainly imagine that artillery does not manœuvre. They harp on the idea of the long range of our guns, not knowing that the long range which is valuable in the construction of tactical problems is of little good in war; and they dwell on the platitude that guns are of no use when on the move. Other officers pretend that the little manœuvring which is to be done may be done by the majors. But, unless the whole rôle of artillery in battle is to be limited to a too indiscriminate hammering of the enemy, there must be manœuvring, and the manœuvres must be directed by an artillery commander. Batteries, once in action, have an inclination to fight straight to their front: they have also an inclination to defend themselves by putting down the fire of artillery, or of distant infantry, who hurt them. Batteries in action should not be left to fight independently, or at the command of any senior officer on the spot: they should be under one commander, who should act in view of a definite object, and carry out the orders of the division general. A lieutenant-colonel or colonel, who is on the division staff and in presence of the division general, cannot command the artillery: he has not rank enough, and he is in the wrong place. The development of the artillery power in battle is hap-hazardous, because the command of the artillery is in commission.

The plan now submitted is that the appointment on the staff should be abolished, and that the artillery brigade should be commanded, like any other brigade, by a brigadier or major-general. The rank is

not out of proportion with the importance of the command. The command is extensive in respect of men, horses, and guns; in battle, it is at least as important as any other brigade command; and at all times in the field, with regard to transport of ammunition and stores, to the practicability of the country for the march of his batteries, and to the guarding of his batteries on the march and in camp, the duties of the artillery commander are heavier than those of any other brigade commander. The artillery brigade should be commanded by a brigadier: he should take his turn with the other brigadiers in the command of detachments of mixed force; and he should be in the succession to the division command. The post and duty of the artillery commander, in battle, have been best laid down in the German field artillery exercise book. He should accompany the division general in the reconnaissance of the ground and the enemy, and take the orders for the artillery: as soon as the fighting begins, he should go to his batteries: it would be the duty of the division general to send any further necessary orders to the artillery commander, and to keep him acquainted with the phases of the situation.

The army would gain by the best officers of horse and field artillery having more chance of attaining high command. From one cause and another, handling of troops in battle is now of more importance than ever it was. Instance, in Europe, the charge of the six squadrons at Vionville, and the placing of the twelve Saxon batteries on a front of 1200 yds. against St. Privat; and consider other things, which, as they were not well done or were omitted to be done, it is best not to particularise here. Take the fighting in Afghanistan, where, as we can no more prevail by the old drill and discipline of our infantry, everything must depend upon the handling of our small forces. Horse and field artillery officers are accustomed from the first to command on parade, accustomed to large mounted parades and manœuvres, and accustomed to parades and manœuvres with other arms: they are trained to manœuvre and must, if they have any talent in that direction, acquire facility in handling troops. The officer who can drill and manœuvre a brigade of batteries well, can drill and manœuvre a brigade of cavalry, and very easily direct the slower movements of infantry: and having these powers in him, and being in practice, he can handle troops. At present, commands are inclined to fall to the infantry and to the staff. Infantry is the most important arm, no doubt; but infantry and staff officers, if we consider their training only, are the least likely to distinguish themselves in handling troops in battle: in cavalry and artillery there is better training for that. There is now only one way to high command open to the artillery, the avenue of the staff: it would be well to lay open yet another way for

them, the best way, the way by commanding their own brigades in the field. The late General Tombs attained high command, without qualifying on the staff; and, surely, he was a bright example of what a general officer ought to be, an example in all things in quarters and in the field, but especially in the facility with which he could handle troops. Few officers can hope to rival Tombs in merit; but our horse and field artillery are very good schools, and a limited career should not be the portion of the officers who are trained there.

Note.—The action fought last year near Gaudamak showed the advantage possessed by officers trained in cavalry or field artillery. With one battalion, four guns and four weak squadrons, we attacked 5000 Khugianis in a good position. It was rather late in the afternoon, and we were three miles from camp, but we had to fight then and there: all the country round was up and awaiting the result: we had to win and to win quickly. Fortunately, our troops were extremely well handled. Brigadier-General Charles Gough of the Bengal cavalry commanded, and his brigade major and orderly officers were 10th Hussars; Major Hon. A. Stewart, R.H.A., manœuvred his guns perfectly; and the late Major Battye of the Guides cavalry charged at the very moment.

24th August, 1880.

THE WELDON RANGE-FINDER.

BY

COLONEL A. W. DRAYSON, R.A., F.R.A.S.

In the December No. of the "Proceedings of the R.A. Institution," there is a description of a method of range-finding, said to have been perfected by Major Weldon, of the Madras Staff Corps. Having had an instrument constructed fifteen years ago by Messrs. Troughton and Simms, identical with that which Major Weldon has lately invented, and having given both the instrument and the method a very extensive trial at Woolwich and Shoeburyness, before Committees, and at Aldershot, I consider it may be of some interest if I give the results of my experience connected therewith.

Finding that persons unused to instruments had some difficulty in setting the index of a sextant to any given angle—such as 84° 17′, 87° 8′, or 88° 34′—I consulted with Mr. Simms, of the firm of Troughton and Simms, as regards constructing a small instrument like an optical square, which should by reflection show these angles only. These opticians turned me out four instruments; one an optical square set to show 90° only, another to show 88° 34′, a third 87° 8′, and a fourth 84° 17′.

After a long series of trials, I selected the optical square, and the instrument showing 87° 8′, and I used these in the following manner:—

The optical square was used to set off the right angle between the distant object and the second observer. The instrument showing 87° 8′ was used to place the second observer so that the distant object coincided in the object glass of the instrument, with the observer using the optical square. The range of the distant object was then 20 times the base.

Example: One observer stands at *O*, using an optical square, the second observer moves to *A*, until at *A* he finds that *O* and *X* coincide in his instrument, showing 87° 8′. The range $OX = 20\,AO$.

One observer can of course do the whole of this.

The base, *AO*, may be paced if great accuracy is not required, but it ought to be measured.

For measuring I used a stout tape on a large roller, and when gunners or private soldiers used this, an error in multiplying sometimes occurred. For example, suppose the base was 69 yds., I have been given the range as 1280 yds. instead of 1380. To avoid this source of error I requested Messrs. Elliot, opticians, to construct for me stout tape, on which *half* yards were shown and numbered, so

that a base 69 yds. long would be shown on the tape, and read as 138 *divisions*. No multiplication was then necessary, as the range was read off at once by annexing 0, and was given as 1380 yds.

The first practical difficulty I encountered with this method was, that if the range should be as much as 4000 yds., the base must be 200 yds. long, and to find a position for a base of such length was often impossible in enclosed countries; or, if the base could be obtained, the distant object—the range of which was required—could not be seen from both ends of the base.

In order to have a choice of positions I usually carried the instrument showing 88° 34′, and when a base of 200 yds. for a 4000 yds. range was not obtainable, I used a base of half the length, and the angle 88° 34′, when the range = base × 40.

Owing to obstacles, the nature of the ground, &c., I found that a fixed base of $\frac{1}{10}$, $\frac{1}{20}$, or $\frac{1}{40}$ the range was most inconvenient in rough country, and so I gave up this method in favour of that requiring a variable angle and any convenient base, the optical square being used as before to set off the right angle, and the pocket sextant being used to measure the angle *KAO*. A table being used to read off the range.

After many years practice in all countries I have found this method the best and most convenient. The errors, with competent observers, vary from 1 to 3 per cent., and the time occupied varies from 1 to 3 minutes.

Captain Everett, 33rd Regt., who was my assistant at the Royal Military Academy, could with me find a range in less than 40 seconds, and with an error rarely more than one per cent., and such results were obtained before a Committee at Shoeburyness.

In all these methods, however, it is necessary, from the principle of the instruments used, that the base should be horizontal or nearly so. In hilly country this is almost impracticable, and great errors will result.

In order to obtain the full benefit of any range-finder, thoroughly competent observers must be employed. To hope that any method of range-finding can be used by men who are unskilled, is a delusion. So that it really seems desirable that there should be attached to each Battery men trained as range-finders, receiving some small increase of pay when thus qualified.

We do not expect that every gunner should, after an hour's instruction, be competent to shoe a horse, and the value of knowing one's range so as not to waste ammunition is certainly of sufficient importance to demand training and attention.

The method of using the fixed angles and variable base, such as 88° 34′, 87° 8′, and 84° 17′, I taught at Hythe to the School of Musketry, also at Aldershot, and at Woolwich about ten years ago. Also, the more useful method of any angle and any base, in order to overcome the defects of the fixed angle.

It will be seen from these facts that the Weldon range-finder is not quite a novelty, and from the supposed perfection of the instrument and the method, it appears that its practical difficulties have not yet been discovered.

DESCRIPTION

OF A

RANGE-FINDER

PROPOSED BY

CAPTAIN F. ROBERTS, R.A.,

BY

LIEUTENANT H. C. DUNLOP, R.A.

In 1875, the Okehampton experimental committee recommended that "every battery in the field should be provided with a powerful telescope, mounted on a tripod." It was to add to the efficiency of such a telescope, that the range-finder, of which the following is a description, was devised:—

The instrument requires one observer, with an assistant, to work it, and consists of,—

(1) A telescope on a tripod.

(2) A graduated rod about 6 ft. long.

(3) A simple calculator.

1. In the focus of the telescope are placed two parallel lines (either cut on glass or made of the ordinary spiders web) which subtend a fixed angle ($\tan \frac{1}{40}$). The sunshade of the telescope carries a double reflecting prism (angle reflected $= 90°$), which can be moved at pleasure opposite to, or away from, the object glass.

The tripod is fitted with a head which gives elevating and traversing motion.

2. A light rod, about $1\frac{3}{4}$ in. $\times$ 1 in. in cross section, has a scale marked on one side. Parallel to, and slightly above, its top edge, is fixed a small telescope with a prism reflecting objects at a right angle. If desirable this rod can be made to fold into a length of 3 ft. 6 ins.

3. A slide rule, about 10 ins. in length, with two scales marked on it. (A description of its construction is given further on.)

When, for military topographical purposes, the range-finder is used in connection with a plane-table, the sights for the latter can be fixed on the reverse side of the calculator.

Method of Using the Instrument.

The tripod is planted in any convenient position. The telescope is focussed (its eye-piece turned so as to bring the two wires nearly vertical) and laid so that the centre of the left-hand wire cuts the object, whose range is required (Fig. I.)

The observer then turns the prism so as to bring it opposite to the object glass, and, taking the graduated rod, walks to the left a distance of from 20 to 80 yds.; then, throwing the rod over his right shoulder, he looks through the rod-telescope, and so places himself as to reflect a fixed mark on the exterior of the tripod-telescope on to the distant object. When exactly in position he calls "ready," on which the assistant, who is now looking through the tripod-telescope, reads the number (Fig. II) opposite the left-hand wire; should the rod not appear in the centre of the field, he turns the sunshade till it does so.

Without removing his eye from the tripod-telescope, the assistant next traverses the telescope so as to make the right-hand wire cut an index on the rod, and reads a (Fig. III) second number on the latter by the left-hand wire. The coincidence of these two readings on the calculator gives the range.

The graduation of the rod is so arranged that if a base of 40 yds. is measured (either approximately by pacing, or accurately by placing the rod at such a distance from the tripod-telescope that the wires subtend the length on it from 16 to $\frac{1}{4}$), then the number which appears opposite to the left-hand wire (Fig. II) when the observer has placed himself at the right angle is the range *instanter*, without a second reading or reference to the calculator.

When repeating a range, the observer should take a pace to his right or left, to ensure fresh readings on the rod. Should the second set of readings give the same result as before, the range found may be depended upon.

In a high wind the second reading should be taken with the rod in a vertical position, index line uppermost, and with the eye-piece of the tripod-telescope turned so as to bring the wires nearly horizontal—this ensures accuracy.

When, owing to fog, objects cannot be seen through telescopes,

sights on the exterior of the tripod-telescope are made use of. The telescope on the rod is removed, and the base made as long as possible. In other respects the range is taken as already described.

Neither of the prisms are placed over the index points; but the distance (about 10 ins.) from the prism on the rod to the ∨ on the rod, is equal to the distance from the index on the tripod-telescope to the prism in its sunshade. This arrangement enables the observer to hold the rod steadily on his shoulder, and does not effect the accuracy of the instrument.

If the parallel lines in the field of the telescope are cut on glass, the instrument is absolutely independent of any adjustment. Should, however, spider webs be employed, it will be necessary to test their distance apart occasionally. This can be easily done by measuring off on the ground a distance of 40 yds. (twenty times the length between ∨ and 8 on rod) and ascertaining if, at that distance, they subtend the length from 16 to ∨ on scale. Should they not do so, they can be corrected in the usual manner.

Another method of correcting the error arising from this cause will be described further on.

The clear definition of distant objects afforded by the telescopes admits of the use of a comparatively short base, which should be selected so as to lie between $\frac{1}{30}$th and $\frac{1}{50}$th in. of the estimated range.

The following are recommended :—

Approximate range.		Base.
1000 yds.	.....	30 yds. (about).
1500 "	.....	40 " "
2000 "	.....	50 " "
3000 "	.....	65 " "
Above 3000 "	.....	75 " "

I took six observations to the same object the second time I saw the instrument. The results varied from 1600 to 1640; the distance, as I measured it on the ordnance map, was 1615 yds. The base used was about 35 yds.

With a 6 ft. rod (graduated from 800 to 4000), the base limits are from 80 yds. to 16 yds. The range limits are 16,000 yds. and 128 yds; so there can be no difficulty in obtaining any ordinary range.

In connection with a plane-table, which is interchangeable with the telescope, the instrument appears to be well adapted for making rapid survey sketches for military purposes—more especially over ground, such as an enemy's position, which cannot be approached, or in a close country where a plane-table would be of but little use.

From a limited number of ranges taken with the instrument, the probable error at 2000 yds. distance was found to be 1·3 *per cent.* It is, however, hardly fair to compare this result with the probable error of other range-finders, as the conditions under which the observations were made may not have been the same in each case.

I hope, shortly, to furnish a statement showing the results obtained by the range-finder in the hands of non-commissioned officers.

Theory of the Instrument.

For simplicity, we assume that the prisms coincide with indices. OI (Fig. IV.) is the range we require. We have seen that OTF (Fig. IV.) and OIT' must always be right angles when the readings are being taken.

Let IF be the distance at the first reading measured on the rod, from the rod-index I to the point F. Thus from Euclid—

$$OI \times IF = (IT)^2 \quad \text{.....(i)}$$

We will now consider the second reading :—

As the permanent angle subtended by the wires is always $\frac{1}{40}$, it is evident that when the right-hand wire is on I, the left-hand wire will be at P, if—

$$\frac{PI}{IT} = \frac{1}{40} \text{ } i.e., \text{ if } (IT)^2 = 1600\ (PI)^2 \quad \text{..... (ii)}$$

and PI determines the second reading.

Substitute in (i) the value of $(IT)^2$

we get $$OI = \frac{1600\ (PI)^2}{IF} \quad \text{..... (iii)}$$

Suppose the base $IT = 40$, then from (ii)

$$PI = 1 \therefore OI = \frac{1600 \times 1^2}{IF} \quad \text{..... (iv)}$$

and with this constant base let any first reading (f) represent the range expressed in yards ; that is let $f = OI$

$$\therefore f = \frac{1600 \times 1^2}{IF} \quad \text{..... (v)}$$

or $$IF = \frac{1600 \times 1^2}{f} \quad \text{.....(vi)}$$

In (vi) give f any value we please (say from 800 yds. up to 4000 yds.), and the scale is graduated by measuring the various values of IF thus obtained, from the point I.

Thus if $f = 1600 : IF = 1$,

so measure 1 yd. from I, mark the rod, and number the mark 16 (hundreds understood).

N.B.—This scale may be made from a table of cotangents. Its index point is cot $0° \times 40$. If the rod is 2 yds. long it would read down to cot $2°\ 51' \times 40$.

Now suppose the base to vary, and any second reading, obtained at

any distance PI from I, to be read on the scale constructed as above by the figure p;

then $$\frac{b}{p}=\frac{IP}{IF} \therefore p=\frac{1600}{IP} \quad \text{(vii)}$$

NOTE.—$p=16$ (hundreds understood) when $IP=1$, *i.e.* when base = 40 yds.

Substituting the values of IF (vi) and IP (vii) in (iii) we get

$$OI=\frac{1600^2 \times f}{p^2}$$

an equation solved by one setting on the slide rule or calculator.

A rough slide rule, for the purpose of illustration, may be made as follows:—

Draw a scale, A, (Fig. V.) with equal divisions, and number them—

log 1=0	write	1	on scale	B	opposite	0	on scale A
log 2=·3	"	2	"	B	"	3	" A
log 3=·477		3	"	B	"	4·77	A

and so on up to 10, which is written "1" on scale B, and may mean one followed by, or preceded by, any number of ciphers, and with the decimal point anywhere. All figures and readings connected with these scales may be similarly treated, as we are dealing with logarithms and can fix the mantissa of the range log by eye.

Mark the two indices at 16 and 5055, *i.e.*, $\sqrt{\frac{16^2}{10}}$.

Make a second scale (C) of the same total length as B, but with the divisions half the distance apart.

Suppose the readings are 156 and 204 (*vide* Figs. II. and III). Set 156 on scale C under 204 on scale B; and the right-hand index on scale B points to 96 on scale C. One can judge by eye whether this means 960 or 9600 yds. (The motion is shown by the parallel dotted lines in Fig. V.)

The slide rule used is twice as long as scales B and C, and is more finely subdivided than they are. The number of subdivisions on the slide rule between any two figures, corresponds with the number between the same figures on the rod-scale.

Should the wires in the field of the tripod-telescope require adjustment, it may be found more convenient to alter the position of the ⅄'s on the calculator to suit them, than to attempt the adjustment as before described.

Place the rod at such a distance from the tripod-telescope, that the wires subtend the length from 16 to ⅄. Then measure the base in

yards and, having squared it, use the figures thus obtained in place of the left-hand ∜ (16). The two ∜'s are always half the total length of the scale B (from 1 to 1 on scale C) apart, so the second ∜ is easily obtained. It may also be found by dividing the first by $\sqrt{10}$.

When the two figures "1" on scale B and C coincide, the scale C reads off the squares of the scale B, so that there is no difficulty in finding the square or square root of any number.

The reason for the above correction of the ∜ is,—

Equation (ii) may be written $(IT)^2 = \cot^2\theta \times (PI)^2$, where θ is the angle subtended by the wires.

$$\therefore \text{ from (vii) } (IT)^2 = \cot^2\theta \times \left(\frac{1600}{p}\right)^2$$

but as p is made equal to 1600

$\therefore (IT)^2 = \cot^2\theta$; and $\cot^2\theta$ is the true reading for the left index on scale B.

Fig

F

F

Fig I.

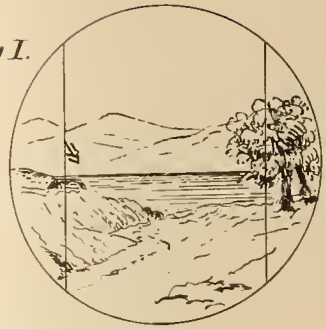


Fig II.

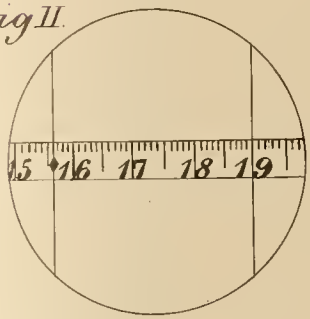


Fig III.

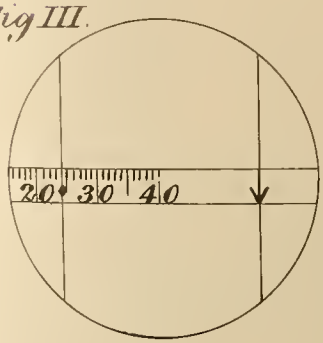


Fig IV.

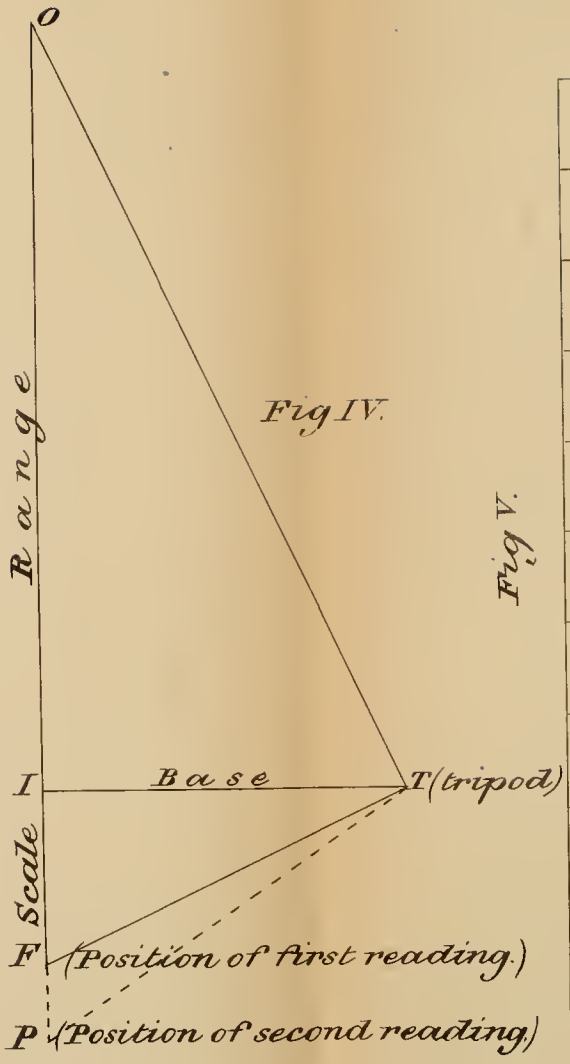
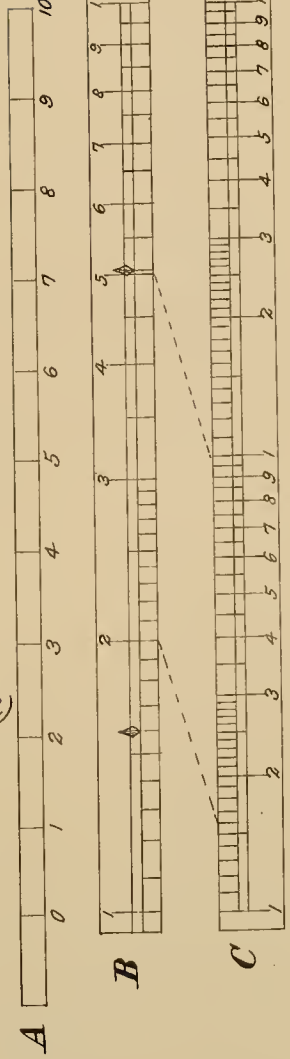


Fig V.



Extracts from the "Revue d'Artillerie," October, 1880.

TRANSLATED BY

CAPTAIN A. E. TURNER, R.H.A.

GERMANY.—ISSUE OF A REPEATING RIFLE.

The experiments of Mauser rifles converted into repeating rifles on the Löwe system, lately carried out at the school of musketry at Spandau, have proved so eminently satisfactory that it has been determined to issue this weapon forthwith to the fusilier battalions of the guard. 12 shots are fired from it in from 22 to 25 seconds, and it is considered by the officers who have superintended the trials, that by means of it, infantry will acquire an immense preponderance over artillery, and that the development of volley firing from repeating rifles will be a great phase in the next European war.

ITALY.—HORSE ARTILLERY BATTERIES.

Early in the year 1872, the Italian Government, from motives of economy, converted the only two horse batteries in its service into field batteries, and in consequence the want of artillery possessing sufficient mobility to follow the movements of cavalry, to act with advanced guards, and to move with rapidity over rough ground has been very severely felt. The war minister, therefore, in place of horse artillery, has taken steps to increase the mobility of certain field batteries, as follows: the teams are altered from four to six horses, and a gunner is mounted on each of the off horses, while, after the system prevailing in the German horse artillery, no men whatever are carried on the gun limber. This will bring the old Bengal horse artillery system to memory. It is urged, against this plan, that in cases where the wagon is unable to keep up with the gun, only four men, including the No. 1, are available for the service of the piece. Very favourable reports upon trials of the above system have been received from the various camps of exercise this autumn, and it is probable that it will be speedily introduced into the service.

RUSSIA.

It is rumoured that the Russian field artillery is about to be reorganised. Hitherto it has been divided into brigades of six batteries, each of which consists of 8 guns; according to the new system, a brigade will be formed of two regiments, which latter will be composed of four batteries of 6 guns each. A brigade will be under the command of a major-general, a regiment under that of a colonel, while the batteries will be commanded by lieut.-colonels and captains.

EXPENDITURE OF AMMUNITION BY THE RUSSIAN ARMY IN THE WAR OF 1877–78.

In the August number of the "Journal d'Artillerie Russe," a very interesting paper on this subject appears from the pen of Major-General Grigoriew. The following tables are given :—

Small-Arms.

	Cartridges expended.		
	Berdan.	Krink.	Peabody-Martini.
By the 23 divisions of infantry	2,984,012	9,914,026	22,315
By the chasseur brigades	1,322,346		
By the sapper brigades	(20,315)*	83,643	
Total by the infantry	4,306,358	9,997,669	22,315
	Berdan.	Krink.	Revolver.
By the cavalry	1,687,610†	108,416	121,020

Artillery.

	Common shell.	Shrapnel.	Case.
9-prs. (Pièces de 9)	92,201	31,323	252
4-prs. (Pièces de 4)	41,464	22,068	283
3-prs. (Pièces de 3, mountain guns)	355	382	50
Total by the artillery	134,020	52,772	585

* Cavalry cartridges. † Besides the 20,315 fired by the sappers.

79 per cent. of the cartridges actually carried by the infantry were expended, and 39 per cent. of the whole of the infantry ammunition, including that carried by the men, and in the small-arm ammunition wagons.

14 of the 23 divisions of infantry served throughout the war, the amount consumed by these was 94 per cent. and 47 per cent., calculated as above.

The 16th division fired the greatest number—viz., 1,421,781 cartridges.

The greatest consumption in any one battle was that made by the 140th regiment at the affair of Karakhazankioï, on the 30th August, 1877, where 94 per rifle were fired.

In the 23 brigades of field artillery the 9-pr. batteries fired 163 per cent., and the 4-prs. 79 per cent. of their regulated proportion of rounds.

The greatest expenditure was by the 3rd battery of the 31st brigade of artillery at the assault of Nikopolis, which fired 180 rounds per gun.

In the cavalry the dragoons expended 129 per cent. of the regulated amount carried by the men, and 64 per cent. of the whole number, including that thus carried, and that conveyed by the small-arm ammunition wagons. The greatest consumption was by the 9th regiment, which fired 44,449 cartridges.

The Uhlans and Hussars expended 229 per cent., and 92 per cent., as above, and the maximum number was fired by the 9th Regiment of Uhlans, which disposed of 29,620 cartridges.

ALDERSHOT,
28 October, 1880.

THE DUTIES OF SUBALTERN OFFICERS:

BY

LIEUT. A. M. MURRAY, R.H.A.

1. For some years past it has been gradually becoming apparent that the position, duties, and responsibilities of the junior regimental officers of the Army must undergo an entire change in order to meet the altered conditions of modern warfare. While on the one hand, owing to the introduction of arms of precision, and the development of military science generally, the task of training soldiers has been rendered more difficult, and while the recruit requires greater individual attention than formerly, on the other hand the time in which his military education is expected to be finished has been considerably shortened, and the means of instructing him have become diminished. The necessity for forming a substantial Reserve of trained soldiers has led to the establishment of a system of short service in the British Army,* which precludes the possibility of the recruit remaining more than a few years with the colours before he is passed into the Reserve. When the full effects of this system are felt, the ranks of the Army will be entirely made up of young soldiers, who, instead of entering the service as used to be the case by twos and threes, will be enlisted in large batches, and will not have the advantage when they begin their military life of being associated with old and disciplined soldiers of long standing. Moreover, we in England are beginning to find, what the German and French military authorities found when short service was first introduced on the continent, that the supply of experienced non-commissioned officers is falling off. The Government are scarcely able to compete successfully in the labour market for ordinary recruits, still less to offer sufficient inducement to the lower middle classes to embrace a military career. As the old non-commissioned officers die out by degrees this difficulty, which is already creating serious inconvenience,† will increase, and will have to be met by offering better rates of pay

* Although it is believed that Lord Airey's Committee have proposed to introduce certain modifications in the Army Re-organisation Act of 1871 with a view to retaining soldiers longer with the colours than was proposed in that Act, still it is understood that the principal of the legislation of 1871, which aimed at the creation of a large Reserve by passing men through the regular army so soon as they had become trained soldiers, is recognised by the Committee as sound. We may therefore expect to find that the short service system of enlistment, though in an amended form, will be enforced by the present government.

† In a paper contributed to the Nineteenth Century for July 1879, entitled "Boy Soldiers," by Lieut.-Colonel W. W. Knollys, the want of non-commissioned officers was alluded to as "the crying need of the present hour."

and pension to non-commissioned-officers generally, and by improving their position in other ways so as to secure the services of a really high class of men.* In any case, however, it is surely upon the commissioned officers of the army that most of the burden and responsibility of training recruits will in future fall. Apart from the fact that there is difficulty in obtaining efficient non-commissioned officers, the work of instructing soldiers has of late years become so enhanced in importance, that it seems to be impossible any longer to relegate it to sergeants.

As Sir Garnet Wolseley not long ago most forcibly pointed out, if our army is to be made fit to meet a European Army on the field of battle, it can only be done by the regimental officers undertaking to train it themselves. †"The Army now is the greatest and most important of our national schools, of which in future the officers will be the masters."

2. It is necessary to bear constantly in mind the significance of the change which has come over the spirit of modern military training. When soldiers fought in rigid lines or massive columns, their training was almost entirely mechanical. Success depended upon the cohesion of the mass, rather than upon the exertions of individuals. In the days of shock tactics indeed a soldier may be said to have had no individuality; he was only the part of a machine which was kept in working order by the maintenance of stern discipline, by strict attention to physical exercises, and by constant practice in mechanical drill. There was no necessity for a higher training, and therefore none was attempted. When a recruit joined all that he had to learn was how to put his legs forward and present arms at the word of command, and the knowledge requisite to enable him to do this could very well be imparted to him by a subordinate non-commissioned officer. Consequently he was handed over at once to the drill sergeant, and did not come under the eye of his officers until he was pronounced fit to join the ranks of his troop or company. His education was completed in the barrack room, where he was soon assimilated and absorbed by his comrades, and in due course of time, without any further effort on his part, took his place in the ranks as a trained and disciplined soldier.

3. It is otherwise now. The days of shock tactics were numbered at Sadowa. Then it was that all Europe understood, what indeed the Germans had long before realised, that a complete revolution had been affected in the principles and practice of modern warfare.‡ The

---

* In answer to a question addressed to him last session in the House of Commons, Mr. Childers said that this matter was under his immediate consideration.

† The Nineteenth Century, March 1878. "England as a Military Power in 1854 and in 1878," by Major-General Sir Garnet Wolseley.

‡ The significance of the change which then took place has been pointed out by many writers, but by no one with so much force as by Brevet-Major Maurice, R.A., the author of the Wellington Prize Essay.

"The radical change which has taken place in tactics is, as it was at the time when the system of Frederick gave place to that of Napoleon, one above all things in organization. But the change is an infinitely more vital and complete one now than then. If a flexible chain was then substituted for a bar of iron, it remained dead metal still, more pliable under the hands of the one man who wielded it, each link capable of a certain degree of independent motion, but essentially it was intended to obey only mechanically the impulse that was imparted to it. We have to provide a new substance. A living organism has to take the place of a material instrument. It must work under the inspiration of the regulating head, rather than move with mechanical precision in the directing hand." The Wellington Prize Essay, page 37.

mere fact of their infantry being armed with the needle gun did not enable the Prussians to beat the Austrians in the campaign of 1866.* Their victory was rather due to the superior training and education of the Prussian soldiers, who were able to use with success a new and delicate weapon, which could never have been trusted in the hands of ignorant men. Had any other troops in Europe been armed at that time with the breech-loader the result would certainly not have been as successful as it was with the Prussian Infantry. Four years later the French Infantry fought with a weapon superior in every respect to the Prussian needle-gun, yet the contest was never doubtful. We can all remember the fears which were openly expressed in England when it was first proposed to arm our soldiers with the Snider rifle; but those fears were never shared by German Officers. They trusted to the intelligence of their men, which they had striven to develop to the utmost so as to enable them to make a right use of the breech-loader on the field of battle. As the author of the "Tactical Retrospect" pointed out shortly after the Austrian war, "the decisive element" in battles was no longer brute force, but rather intellect (geist), not only on the part of the leader but from him down to the last soldier in the army. "Undoubtedly," wrote Mr. Gladstone in 1870, "the conduct of the campaign on the German side has given a marked triumph to the cause of systematic popular education. The mind has now gained a point in competition with its material partner."†

4. It was Prince Frederick Charles who gave the first impulse to the movement which led to the "individual order" of fighting. In the celebrated "Military Memorial" addressed to the officers of the Prussian Army, and in which the Prince set himself to answer the question, "How to beat the French," he laid down three conditions as necessary for success; "(1) to develop the military qualities of each individual soldier earnestly in time of peace; (2) to give the army leaders who have a thorough acquaintance with the three principal arms; (3) to oppose to the French a more varied and elastic form of tactics."‡ It was to carry out the first and most important of these conditions that the energies of Prussian officers were chiefly directed from 1860 to 1866. The "Military Memorial" was followed in 1861 by the issue of a code of "Tactical Instructions,"§ which were published as a guide to regimental officers in carrying out the new system of tactics. These "Instructions" mark a fresh departure in the military history of the German nation. From the date of their issue, officers were to cease to confine their own training, and that of their men, to

* "The individualisation of the fight is not a consequence of the breech-loader, but the breech-loader is rather a consequence of the qualities of the Army, which has arrived at the degree when the arm became necessary. Breech-loaders have been known for centuries, and if they have now been found practical, the reason is to be looked for in the fact that the Army has now for the first time shown itself ripe to appreciate their merits * * * * In the strife of the individual armies of Europe for the leading place, those powers will not gain the day, whose arm can be discharged ten or twenty times a minute, but rather those who demonstrate in the most substantial manner the enlightened views of the present time." Tactical Retrospect, 1866.

† Edinburgh Review, October, 1870. "Germany, France, and England."

‡ The Military Memorial: translated from the Frankfort edition of Prince Frederick Charles's Essay, "How to beat the French," 1860.

§ "The Prussian Tactical Instructions for Grand Manœuvres," translated by Sir Charles Staveley.

the mere acquisition of drill. It was impressed upon them that the moral and intellectual faculties of all soldiers must be developed side by side with their physical powers. They were to teach their men the value of self reliance, and self control, the necessity for exercising their judgment, for using their intelligence, for learning to think and act for themselves when the eye of their officer was no longer upon them. Above all they were to emancipate themselves from the cumbrous traditions of the military system of Frederick the Great.* It was upon this that Prince Frederick Charles insisted with all the vehemence of a true reformer. "If Prussia," he wrote, "puts to herself this haughty question, What will be our fate in a war with France? we can conquer, I shall answer; and we shall conquer her with a certain blow, if we know how to detach ourselves in time of war, from the routine of the drill ground, the demands of regulations, and from our system of skirmishers. Here is the difficulty; this is my only anxiety. The motive power which these forces give us is unsufficient to maintain discipline, to bring the soldiers up to the enemy, and to make them sustain their fire. Thank God we have others, and we shall know how to bring them to our aid."

5. The changes which were introduced in 1861 into the system of tactics were accompanied by corresponding changes in the administration and interior economy of the Prussian Army. Then was established that admirable system of regimental organisation, which was so devised as to give full effect to the new ideas, and to develop to the utmost the fighting powers of every individual officer and soldier. The key note of the system is decentralisation to the smallest unit. In the German army every officer and soldier has his position, duties, and responsibilities definitely fixed and clearly understood. All have a certain charge entrusted to them, a certain responsibility to fulfil. There are no seconds-in-command, or other irresponsible officers; everyone is the

---

* In a paper contributed to the October number of the Edinburgh Review for 1870 entitled, "The Campaign of August," which was generally attributed at the time—and I believe rightly so—to the pen of Colonel Chesney, the Tactical Instructions were alluded to as follows:—

"From the time that this work was published, the system of rule and theory, by which officers were made drill-masters without being soldiers, which substituted parade ground practice for the imitation of real war, vanished from the Prussian service. All attempts to handle methodically a larger body of men than one brigade were dropped from the service; and in their place came field manœuvres, conducted so as to interest and teach each person employed, and to bring vividly before the minds of the higher officers the necessities of an actual campaign. The pedantry which had attempted to prescribe by minute rules for every contingency, and to take away from every individual all responsibility, save that of following the written law, was absolutely swept away, and in its place was put a set of sound, well-considered principles, the carrying out of which into practice was left in the main to the discretion and independent judgments of the officers concerned. This is the leading idea on which the 'Instructions" are framed throughout. They aim at being no more than a general guide for the use of intelligent agents, for thoughtful and well-trained leaders. No one who catches the spirit of the "Military Memorial" will be surprised that its author has from the first been credited with inspiring the "Instructions," which have made that spirit the rule of the Prussian service, and have given each member of it that individuality which the Prince was the first to claim for him, and to each leader that moral lever wherewith men are raised in the face of danger to the greatest deeds of valour."

commander of somebody or of something. The general commands his division, the brigadier his brigade, the colonel his regiment, the major his battalion, the captain his company, the lieutenant his half-company, the sergeant his section, the private has charge of his rifle, the gunner of his gun, the driver of his horse; all form links, so to speak, of a chain which extends unbroken from the general to the soldier.* However great or small the responsibility of each is, it is absolute as far as it goes. Provided everyone does his work well, and satisfies his superiors at the periodical inspections, he meets with no interference either from above or from below. On the contrary the utmost latitude is allowed to all. At the inspections, which are of the most searching nature, officers are expected to produce certain results, but it is left to themselves to work out the particular way and means by which those results are to be obtained. The battalion commander delegates the greatest amount of authority and power, consistent with the maintainence of his own command, to the captains of companies, who in their turn apply the same principle in dealing with their subordinates, and hold their two subalterns responsible for the efficiency of their half-companies, abstaining as far as possible from interference with their executive work.† A lieutenant in the German army has in this way a command, smaller indeed, but as independent as that of his captain: and provided he gives satisfaction at the inspections he is allowed in his work the same latitude and discretionary power, which is allowed to the captain by the major, and to the major by the colonel.‡ In the same way the

---

* "Every man seems to be in his place, and to know his proper business. The finished intelligence, of large reach and measure, which presides over the whole strategic operations of Von Moltke, is proportionally represented in every military organism from the Corps d'Armée to the company. Miscarriage or mistake seems no more to adhere to their ordinary operations, than to the working of the machinery of a cotton factory. But when any of these masses are resolved into their parts, the units too, of which they are formed, have each had their separate training, and each is capable of acting alone in his own sphere." Edinburgh Review, October, 1870. "Germany, France, and England."

† The following anecdote related by Colonel Kaulbars, a Russian officer sent by his government to study the German military system, was alluded to by Colonel Hale, R.E. in his paper published in Macmillan's Magazine, on the "Spirit of the military training in the German Army," as an instance of how German officers abstain from interfering with the executive work of their subordinates. It is worth re-producing here. "I heard," said Colonel Kaulbars, "a general one day express to a captain under his command his astonishment at the method the latter was following in training his company. "Acting as you do," said he to the captain, "I will engage that you do no good." Closely observing this company for the next four weeks I saw the captain steadily pursuing the course he had originally adopted. At the inspection of the company, which was made by the commander of the regiment, the captain came off with flying colours. The general was present as a spectator, and thus addressed the captain publicly, "I ought to acknowledge that you have beaten me, and although certain details should have been otherwise treated, you have obtained results very different from what I anticipated." He then congratulated him warmly, and added, turning to us: "Gentlemen, this shows that one is never too old to learn."

‡ The same Russian officer alluded to above, inquired from a German captain what amount of supervision he exercised over his subordinate officers. He received the following remarkable answer. "We take special care not to live near the barracks; our doing so would be a restraint on the lower ranks, and the result would be this: that the commanding officer being always present at the drill would, in spite of himself, interfere with it, and would destroy all initiative among the instructors. It is not we who conduct the drills; we ought therefore to appear on the drill-ground only occasionally, to assure ourselves; that things are going on properly." Macmillan's Magazine, July, 1868.

responsibility descends from the lieutenant to his sergeant, from the sergeant to his corporal, and so on down to the private soldier. The Germans lay great stress upon the importance of maintaining intact this chain of responsibility, and senior officers are specially careful never to break the chain by giving orders to subordinates except through the proper channel. It is the thorough way in which responsibility is decentralised, and power delegated through all ranks, which is so marked a feature of the German regimental organization, which is indeed the backbone of that organization, and to which is due in a great degree the recent successes of the German army.

6. In the German army there are no specialists. A specialist is essentially the creature of centralisation. He is an individual specially trained and specially paid to do the work of another person. Specialists therefore can have no locus standi in an army which is organised upon the principle that everyone should do his own work, and only his own work, and should not allow some one else to do it for him. Their existence would in fact strike at the very root of that regimental system, upon which, as has been pointed out above, so much value is placed in Germany. It is the regimental officers themselves who have to do the entire work of instruction in the German army, and in them is vested the whole responsibility for the practical and theoretical training of recruits. There are no riding masters, no gunnery instructors, no adjutants, orderly officers, sergeant-majors, and other similar individuals to come between German officers and their men. The Cavalry officers conduct the riding drill of their own troops, the Artillery subalterns teach the men of their own divisions the practice and theory of gunnery, and the Infantry officers carry on the work of musketry practice without the extraneous aid of trained instructors. Every German regimental officer is expected to be thoroughly conversant with the most minute details of drill and interior economy. He is moreover—and this is a most important point—not only required to know his work, but also to do it. Among German officers the cry of "Sergeant-Major, go on" is never heard. "In my regiment," a German officer once said to the writer," it is our boast that we officers never ask our men to do what we cannot do ourselves." It must not be supposed, however, that from the constant habit of imparting instruction, and from intimate association with their inferiors, the German officers allow themselves to be turned into drill sergeants; on the contrary, as Colonel Hale has pointed out,* the greatest care is taken that the time of officers is not wasted on the performance of nominal duties. Every officer has his own sergeants, who carry out the actual details of instruction under his immediate personal supervision; and although his daily duty is—as it should be—chiefly concerned with small details, still the tendency of the German system is to economise the labour of officers, and prevent their time being frittered away on trivial matters,† while their more

* Macmillan's Magazine, July, 1868. "Notes on the German military system," by Lieut.-Colonel Lonsdale A. Hale, R.E.

† "The orderly officer with his inquiry as to 'complaints,'" wrote Colonel Hale, "may be said not to exist in the German service. It is only in large garrisons that an 'officier

important functions are allowed to be neglected. If anyone cares to learn how a German subaltern officer spends his time he should read some of the journals of the German Infantry captains, ‡ a series of which were published some time ago, and which narrate in detail how the daily duties of all ranks are conducted. It is impossible after reading these journals not to be struck with the thoroughness of the work done by German regimental officers. Certainly the charge of being flâneurs in uniform could never be brought against them. They are real working men. The reality and energy with which they apply themselves to their work make a system of short service perfectly easy to carry out in Germany. As recruits become trained and take their place in the Reserve, there is ever present a body of highly trained officers, who form the permanent element in the German military system, and who are ready to take in hand a fresh supply of recruits and convert them into trained soldiers. If then, it be asked, to whom especially is due the success of the German military system, we should, I think, point to the regimental officers, who by their steadfast and earnest labours have raised the army to the highest perfection ever known in history, and have put into the hands of the German Emperor "the most tremendous weapon that the skill of man has ever forged."

7. When we turn from the German regimental organization to consider that of our own army we cannot fail to be struck at once with the wide divergence which exists between the two systems. Take by way of illustration the case of a battalion of infantry or a regiment of cavalry. Instead of responsibility being distributed through all ranks it is centralised in a single individual. The commanding officer is the source of all power, and all authority: from him emanate all orders; he alone has the right to initiate; in him the entire governing power is vested, and assisted by his staff he works the whole regiment without reference to any subordinate authority. The adjutant is held responsible for the drill of the recruits, the musketry instructor for the shooting of the men, the riding-master (in a cavalry regiment) for the riding and fitting of appointments, the veterinary-surgeon for the care of the horses, the quarter-master for the clothing. In all these arrangements the regimental officers—the captains and lieutenants of troops and companies—have no real voice whatever. Day after day they see their men marched off first to one specialist, then to another, without any reference to themselves. Certain routine duties, chiefly appertaining to parades and the maintainence of discipline, they are expected to perform, but in all the real work of the regiment the regimental officers cannot be said to have any actual share. What is demanded of them is that they should be gentlemen, should set an example of honourable and manly conduct, dress well, be pleasant companions at

---

de jour' is detailed: for this officer's interference being called for about once in ten years, it is bad economy to lose daily the amount of useful work represented by one day of an officer's life." Ibid.

‡ "Extracts from an Infantry Captain's Journal," by R. Von. Arnim Major, commanding a battalion of the Hohenzollern Fusilier Regiment, translated by Major C. J. East, D.A.Q.M.G.

mess, especially be good sportsmen, and that they should at the same time perform with the utmost regularity certain routine work when they are "on duty." This work consists chiefly in mounting guards, visiting sentries, going round barrack rooms, and inquiring after complaints. Is it to be expected that an English gentleman of culture and education will throw himself, heart and soul, into work of this description? However high his aspirations, however energetic he may be, however willing to work, it is simply impossible for a subaltern officer to find sufficient in his daily regimental duty to absorb his interest and occupy his attention. He will inevitably look outside his regiment for employment and for amusement; and in course of time his profession will appear to him as of only secondary importance in his life. How can this be otherwise? No one will go on for long performing mechanical work with undiminished energy and unflagging zeal. If you want to get work out of a man give him responsibility: give him power. Encourage him to assume authority, to exercise discretion, to trust to his own judgment rather than to rely always upon that of others. Above all bring him constantly face to face with the difficulties of an independent position. Make him feel that that position is a reality, and that upon his zeal and devotion to his work will depend the welfare of those under him. You will surely succeed in putting him on his metal, and in rousing him to a sense of his high responsibilities. He will cease to regard his duty as something which he must grind through as best he can, but will look upon it as pleasant and congenial work to be done for its own sake, and for the results which are produced. This is the spirit in which German officers are trained and are taught to train their men. It is the consciousness of the reality of their work which gives them strength, day after day, to perform duties which to English officers would seem irksome and unnecessary. "Not in any spirit of pedanty, not with any striving after mere effect, is this system carried out. The one thought, the one wish in the mind of the captain, in the mind of every German officer, is to do in peace only that which prepares a man for actual war service."*

8. Our own regimental organization is based upon the same system of centralisation which has been described above as existing in the Cavalry and Infantry of the Line. No one, who understands the interior economy of a battery of Artillery, can surely fail to be struck with the inordinate amount of work done by the commanding officer compared with that done by the other officers of the battery. The captain has no responsibility whatever, the lieutenants have only a nominal one.

In theory, a lieutenant is supposed to command his division, but in practice how often is this so? If we analysed the daily life of a subaltern officer of Artillery, we should find that in the great majority of cases his duties dwindled down to those of mere cursory supervision.

As in a regiment of Cavalry or Infantry, so in a battery of Artillery,

---

* "The spirit of the military training in the German Army," by Lieut.-Colonel L. A. Hale, R.E. Macmillan's Magazine, May, 1878.

the chief share of the work, and the whole burden of the responsibility, fall to the commanding officer.* Aided by his staff-sergeants, who in a battery correspond to the adjutant and quarter-master of a regiment, he arranges daily for the drill, training and instruction of the men, and carries on the whole work connected with their pay, clothing, and general welfare, without any reference to the officers commanding divisions. In almost all the batteries of the regiment, the sergeant-major is the right hand man of the commanding officer, and it is to him that he looks, rather than to his divisional officers, for the execution of his instructions. If they are present the subaltern officers attend parades and mid-day stables, but the work of the battery goes on quite irrespective of whether they are present, or absent on leave.† They cannot therefore be said to command their divisions.

Their role is rather to preserve order and discipline, and see that the work is properly carried out, than do any actual work themselves. Their functions are those of policemen, rather than of instructors and commanders. The principle that all orders from a superior should be transmitted through the proper channel, and that no orders should ever be given over the head of a subordinate, is rarely observed in the lower ranks of the regiment. Yet the principle is considered of vital importance in the German army, is jealously regarded by the junior regimental officers, and is uniformly and consistently enforced throughout all ranks. We have, too, in the regiment a system of working by means of "Orderly Officers," which it must be acknowledged is incompatible with the proper decentralisation of responsibility—the essential condition of which is, not only that everyone shall have his own separate charge, and be entirely answerable for that charge, but that he shall also perform the daily duties connected with that charge. An orderly officer is detailed weekly or daily for battery duty. If he only performed purely orderly work such as guard mounting, collecting and making reports, and other similar routine duties, there would be no objection to raise to his office. But the custom has grown up of the

---

* May we not look forward to the day when this term, "commanding officer,"—the symbol of centralisation—shall be erased from our military vocabulary, and when the word "commander" shall be substituted in its place? we shall then speak of "brigade commander," "battery commander," "divisional commander" and "sub.-divisional commander." In a thoroughly decentralised military organisation, like that of the German Empire, every one is the commander of somebody from the general down to the private soldier. Before this hope, however, can be realised we must get rid of the notion that it is possible to fix a "unit," where for tactical and administrative purposes decentralisation must cease, and centralisation begin. Decentralisation should be continued down to the *individual*. This is the great lesson to be learnt from modern battles, and at the risk of repetition, we cannot too often impress it upon our minds. "What we really require"—wrote Bt. Major Maurice in allusion to this question of "units"—"is that each body shall be so perfectly built into every other that at each successive stage of the building a perfect unit shall be formed. A brick is not less complete because it is arranged in a course, or a course less regular because it is built into a wall: nor does a wall less perform the special part assigned to it because it forms one of the sides of a house."

† They are thus placed in an absolutely irresponsible position. Can we wonder if under this system subaltern officers endeavour to get as much leave, and do as little work as possible? It is only when a man finds that his labours are really necessary, and cannot be neglected, that he will devote his whole energies to his work.

orderly officer, while he is on duty, undertaking work which is not strictly his own. Instead of each officer being present daily with his division, attending all parades of the division, training the men of the division, and acting as their immediate commander, the orderly officer as a rule performs these duties for all the other officers of the battery. Provided they are present at the commanding officer's parades, they may spend the rest of their time pretty much as they please until their tour of duty comes round. Is it possible for this orderly officer, vested with a kind of general, undetermined responsibility, to feel the same interest in his work which he would feel if he had only a special charge to answer for? We subaltern officers who do the work know that it is not. We know that this system encourages us to do only what we are absolutely obliged to do, to conform to the letter rather than to fulfil the spirit of our commissions. It is often said "There is a certain amount of work to be done. It does not matter very much who does the work, so long as it is got through." I respectfully but most emphatically submit that it does matter very much. This is in fact precisely the point at issue. In future the men who do the work are those who will have the power. The day has passed away when all that was required of a British officer was, that he should be able to stand up as the officers of the Royal Welch Fusiliers stood on the banks of the Alma, and were all shot down because they were too proud to stoop for shelter from the Russian bullets. War has now become one of the most highly developed of modern sciences. The power of officers to lead no longer depends upon their birth, nor upon their manly and gentleman-like conduct, nor even upon their bravery and physical powers alone; but upon their moral and mental superiority, upon their capacity to make men follow where they wish to lead them, upon their ability to perform themselves all that they demand from their followers. The aim of every officer should be to get his men to look to him intuitively for leadership, and to believe implicitly in his ability to guide them in danger. But confidence is a plant of slow growth. An officer who only gives a spasmodic attention to his duties may be able to satisfy his own conscience, but he will never gain the confidence of his men. He who now seeks to be the leader of his men must lead in fact as well as in name, by placing himself at their head as their commander, their instructor, and their "master." He must consent during these long years of peace to share with them the dull, dry drudgery of the daily routine of military life. Every time he goes away and delegates his authority to the orderly officer he breaks the bond of union between himself and his men, he widens that "gulf of etiquette," which Prince Frederick Charles in his "Military Memorial" pointed out as existing at that time so unhappily between the Prussian officer and the Prussian soldier. No one was more keenly alive to the shortcomings of our regimental system in so far as it affected the junior officers of the Army than the Duke of Wellington. His despatches are full of earnest words of exhortation to the young officers of his army, and are sometimes marked with the bitter sense of disappointment which he felt when they would not follow the high example which he ever set them. In his famous minute upon the discipline of the army, which he wrote in 1829 for the consideration of government, he alluded

to the junior regimental officers in the following words, which it will not be inappropriate to quote in full at the end of this paragraph. "Our officer is a gentleman—we require that he should be one, and above all that he should conduct himself as such; and most particularly in reference to the soldier, and to his intercourse with the non-commissioned officers and soldiers. Indeed, we carry this principle of the gentleman, and the absence of intercourse with those under his command, so far, as that in my opinion the duty of a subaltern officer, as done in a foreign army is not done at all in the British army. It is done by the sergeants. Then our gentleman officer, however admirable his conduct on a field of battle, however honourable to himself, however glorious and advantageous to his country, is but a poor creature in disciplining his company in camp, quarters, or cantonments. The name, the character, the conduct, the family and relations, the fortune, the situation, the mental acquirements of each of the men of his company, are not the sole objects of his thoughts, as the same of his men are of the Prussian officer in the same situation, who carries into execution this same discipline in the company to which he belongs with the men of which he lives as a companion, friend, and adviser."*

9. The tendency of late years in the Royal Artillery has been towards decentralisation in so far as freeing commanding officers of batteries from unnecessary control, and giving them more latitude in the exercise of their commands. The practical proposal, which is now suggested, is that this principle be extended still more, so as to place every subaltern officer in the position of the responsible commander of his division. This would be quite possible if the duties of the battery were carried on divisionally, if divisions were always kept intact, and worked under their own officers. The subaltern officers would attend at the battery office every morning, and receive their orders direct from the battery commander—they themselves communicating these orders personally to their two sergeants, and acting as the executive of the commanding officer in carrying them out. If, for instance, the commanding officer ordered the gunners to be exercised in standing gun drill, instead of the whole battery falling in, as is now generally the case, under the sergeant major or assistant-gunnery-instructor, each officer would parade the gunners of his own division, and drill and instruct them himself. In the same way, sword and riding drill could be carried on by divisions—the divisional officer in all cases being the instructor. Would it not be possible also to set apart one day every

* Since these words were written by the Duke of Wellington, great improvement has doubtless been made in the theoretical instruction and training of junior regimental officers, but is there any change in their practical duties as soldiers? This is the question we must put to ourselves. Theoretical study is only useful as a preparation for practical work. All study of war, all talk about war, all drawing of sketches, road reports, lectures on tactics, competitive examinations, and the like—these are but as the sounding brass and the tinkling cymbal, unless the knowledge acquired in these theoretical studies is daily applied to the performance of practical work. Is there not a danger in these days of mistaking pedantry for real knowledge? Knowledge is certainly power, but the kind of knowledge necessary to enable officers to lead their men in war cannot be learnt from books: it can only be acquired by working with them in peace.

week to be called the "subaltern's day," when the divisions would be placed entirely at the disposal of their own officers? All the subaltern officers would then have opportunities of taking out their divisions by themselves in drill or marching order, and exercising their two guns independently. Whenever possible, arrangements could be made by which officers would be allowed to manœuvre their two guns in combination with small bodies of other troops. This plan of dividing up the battery into divisions, and detaching them under their own officers, would surely be of the utmost value in getting the junior officers and men to work together in the field: especially would it tend to give officers confidence in themselves, and teach them thus early in their military career how to handle artillery boldly, fearlessly, and yet prudently in action. Is not tactical knowledge and practice the great want of the present day, and would not the system here advocated tend towards improvement in this respect? The annual practice might also with advantage be conducted according to this method. At present the practice is carried out under the immediate executive control of the battery commander, who arranges all the details of the shooting, and draws up the practice report for the whole battery—the divisional officers only exercising a kind of general supervision. If each subaltern officer conducted the practice of his own division independently, and drew up his own practice report, submitting it to the battery commanding officer, would not this system be more likely to ensure careful practice, to promote a spirit of friendly emulation among marksmen, and induce officers to take greater interest in the shooting of their men than they now do? Is it not the case as a general rule, that the lower decentralisation is carried, the better work is done, because more are interested in the results?

10. In addition to holding subaltern officers responsible for the drill and instruction of the men of their divisions, it would seem advisable, in order to carry out thoroughly the system of decentralisation, to make them more completely answerable for the discipline of those under them than is now the case. At present they have no legal disciplinary powers whatever.* When any of the men in their divisions misbehave themselves, the usual course adopted is for the sergeant-major of the battery to confine them as prisoners in the guard-room.

---

* Military law, as at present enacted, only recognises the "commanding officer" as having the power to punish. As long as all authority and responsibility were centralised in this single indvidual, the "commanding officer," the limitation of the power of officers to punish is intelligible, and strictly logical. Inasmuch as the commanding officer was held solely responsible for the discipline of those under his command, it was clearly inexpedient for his subordinate regimental officers, holding a position of no responsibity, to exercise disciplinary powers as well as himself. When, however, authority becomes decentralised, and when every regimental officer has a certain definite charge to answer for, it follows that powers of punishment in proportion to his responsibility should be conferred upon him so as to enable him to enforce the necessary discipline. The soundness of this argument is testified to by the fact that, when some years ago the call for decentralisation was first heard, the powers of punishment delegated to commanders of companies, troops, and batteries was extended, and they were allowed to award sentences of confinement to barracks for seven days, in place of three days, which had up to that time been the limit of their powers of sentence.

The next morning they are brought up direct before the officer commanding the battery, without (except in very special cases) appearing before the officer commanding their division. However convenient this system may be, however calculated to secure uniformity in punishments, it is clearly inconsistent with the maintenance of that chain of responsibility, the value of which in modern military organization it has been the endeavour of the writer to demonstrate in this paper. If, however, certain * minor powers of punishment—such as the power to award confinement to barracks for 3 days, the power to sentence a man to perform an extra guard or picquet, and other small disciplinary powers—were conferred upon all subaltern officers commanding divisions, and if these powers were recognised as legal in the Army Discipline Act, all prisoners might in the first instance be brought before their own divisional commanders, who would keep the defaulter sheets of their men, and who would either dispose of the prisoners themselves, or would bring them before the major commanding the battery for further punishment. The subaltern officers would thus be answerable to the major of the battery for the discipline of their divisions, exactly in the same way as the major is answerable to his lieutenant-colonel for the discipline of the battery. The possession of disciplinary powers, and the constant necessity for exercising those powers, would surely bring home to us subaltern officers in a practical way the responsibility of our position. We should be compelled to interest ourselves more than we now do in the character and lives of our men, our authority and influence over them could not fail to be strengthened, and we should daily gain that tact and experience in dealing with our inferiors, which it is so necessary to acquire before being promoted to fill positions of higher trust. In view too of the altered conditions of enlistment and the difficulty of obtaining non-commissioned officers of experience, this change seems to be particularly expedient. On all sides we hear complaints of the want of judgment on the part of the young non-commissioned officers of the present day in their relations with the men under them. If the junior officers were brought more into contact with the men, checks would in this way be imposed upon the arbitrary conduct of non-commissioned officers, military law would be more impartially administered, and the general tone and discipline would surely be improved.

11. If this system of decentralisation were carried out as has been proposed above, the battery commanding officer would be relieved of

---

* It may be objected that subaltern officers are too inexperienced to be trusted with these disciplinary powers, and too young to carry out the details of executive work. The answer to this objection is that real work and responsibility have always been found to sober men down, and fit them for their position. A subaltern officer will never gain experience by simply following his major round the stables, and watching the sergeant-major drill the battery. The best way to learn is, as we all know, by teaching others. As long as a man is kept in a state of tutelage he will never really exert himself to the utmost of his powers. It is only when he is brought face to face with the difficulties of life that he will settle down in earnest to his work, and that he will show what sort of stuff he is made of. "A man soon grows on the battle field," was Napoleon's reply to the French Directory when, after applying for a command, he was taunted with his youth.

many of those petty details of executive work, which at present occupy so much of his time, and prevent him giving his attention to higher and more responsible duties. It has been somewhere stated that the true functions of a commander are to combine the development of the individual initiative with complete subordination to control. While therefore the battery commander would delegate as much power and authority as possible to the divisional officers he would continue to exercise a constant supervision over their work.* Without interfering more than necessary he would see that the instruction was properly carried out according to his orders, he would point out errors, and would seek to secure uniformity, which could never be obtained if too great latitude were permitted to subordinates, and if they were allowed to get beyond the control of the guiding hand. On this question of regimental organization the author of the Wellington Prize Essay wrote as follows in 1871. "If the habit be once acquired of being never intrusted with authority in even a limited degree, and of leaning always on the mere dictation of others, it becomes extremely difficult in later life for any man to shake himself free from it, and either willingly to assume responsibility, or—for the two things almost universally run together—to delegate power." These are weighty words. They were written by an English Artillery officer soon after the fall of the French Empire at the battle of Sedan, where the baneful effects of centralisation had been so disastrously illustrated.

12. If the system was established of battery officers carrying on the duties of training and instruction under the orders of the battery commander, there would be no necessity for the intervention of special instructors.† They would cease to exist from the sheer want of occupation. That this would be a step in the right direction, and that the work would be better done is surely beyond doubt. The special instructor, however well trained he may be, however zealous and energetic, has not the same direct interest in the men under instruction as their own officer would have if he were held responsible for their progress. The intervention of specialists is moreover an indirect reflection upon the capacity of the battery officers, and cannot fail to have a detrimental effect in regard to their relations with their men.

---

* The integrity of the battery would in no way be interfered with; its component parts would only be broken up into more complete units, capable of being re-united when necessary. ' A more elastic but a stronger bond must by these means, as well as by others, be substituted for that which we have—not because it is less essential than formerly that the whole army should be closely bound together, but because there is constant danger lest the bond should snap." Wellington Prize Essay, page 55.

† Special instructors of a certain class would still have their rôle, but that rôle would rather be to instruct regimental officers and non-commissioned officers than to perform any executive work themselves. The superintendent of the Riding Establishment is in this way a specialist, but a specialist in the right place. He is at the head of the regimental school of instruction in equitation to which officers and men are sent to be trained in order to fit them for the duty of training others. The brigade riding master however who interferes with the executive work of battery officers is an instance of a specialist in the wrong place. In the same way the commandant of the school of gunnery and his staff of instructors are specialists of the right class; while the brigade gunnery instructor, doing executive work, comes under the same category as the riding master and musketry-instructor.

If men see that their own officer cannot be trusted to instruct them—not be it observed in any special knowledge, but in their ordinary regimental duties—they will inevitably lose faith in his ability to lead them. It is on these grounds most earnestly to be hoped that steps will shortly be taken to absorb all specialists, and transfer* their duties to battery officers. In advocating the abolition of special instructors the writer believes that he is supported by the general feeling of the junior officers of the regiment. Their employment has been condemned by nearly everyone whose opinion is really worth having, by no one more than the Quarter-Master-General of the Army. "The days of special instruction for the education of recruits are numbered," wrote Sir Garnet Wolseley more than two years ago,† "and company and troop officers must learn to teach their own men to drill, to shoot, and to ride without the assistance of musketry and gunnery instructors or of riding masters."‡

13. The title which is written at the head of this paper may at first sight seem to be out of place in the journal of the Royal Artillery Institution. Undoubtedly questions concerning the *personnel* of the army cannot be discussed with the same freedom as questions relating only to the *matériel*. But the two subjects cannot be separated. Modifications in the one demand corresponding changes in the other, and progress in military science can only be achieved by the mutual development of both. Ought we therefore to exclude these subjects altogether from our discussions?§ It is against orders to prejudge military questions which are known to be under consideration by premature discussion; but the calm and sober treatment of subjects of general interest, so far from embarrassing the authorities, will surely

---

* It would seem just to transfer their pay also.

† The Nineteenth Century, March, 1878. "England as a Military Power in 1854, and in 1878," by Major-General Sir Garnet Wolseley.

‡ Nor should we forget the opinions of our own Colonel-in-Chief regarding the duties of subaltern officers—opinions which he has so frequently and so earnestly expressed. The writer well remembers standing as a cadet before His Royal Highness, together with others of his commission class, before leaving the Academy, when the Commander-in-Chief delivered one of those soldier-like addresses, of the art of making which he is so great a master. "Gentlemen," said His Royal Highness, "you have had the benefit of a highly scientific education. I congratulate you upon the fact. Depend upon it you will reap the fruits of your studies hereafter, and they cannot fail to exercise a great influence over your future lives. But do not forget that as subaltern officers you will be charged with the execution of small details of work. I ask you then to continue your studies certainly, but also to apply yourselves to the practical work of your profession. Give your whole energies to your daily duties, no matter how small, or how insignificant they may be. I speak to you as one who knows something of the British army and of British officers. Remember then, gentlemen,—and these shall be my last words to you—*no detail is too small for a subaltern officer.*" Not to multiply authorities it will be sufficient, in addition to the above, to quote the opinion of Bt. Major Maurice, R.A., the author of the Wellington Prize Essay. "It seems to me" he wrote "to need no proof, that if our future fighting is to be of the kind I have maintained it must be, then the instructors of the men must be superintended by company officers, not by adjutants or musketry-instructors. Analogous changes will be required in each of the other arms." Wellington Prize Essay, page 56.

§ "Furthermore officers and soldiers are forbidden to give publicity to their individual opinions, in any manner tending to prejudge questions that may at the time be undergoing official investigation by the military authorities." Queen's Regulations. Section 6, para. 45.

serve to strengthen their hands. No cause has contributed so much in the past to the efficiency of the German army as the existence of a strong, healthy public opinion extending through all ranks of that army, which, without forcing the hands of the government, has ever been instrumental in indicating the direction which Reform should take. In this way the vigorous growth of German military institutions has been constantly promoted in a strictly conservative manner. From time to time improvements have been made which have brought those institutions into harmony with the spirit of modern warfare, and have thus obviated the necessity for sudden and radical change. Did not France on the contrary owe her misfortunes in 1870 to the absence of that public opinion which had acted so helpfully in the case of her adversary? Under the Empire discussion was invariably stifled, and criticism sternly suppressed. The language of flattery and self-congratulation could alone gain a hearing. If a Stoffel or a Trochu ventured to utter words of warning they were allowed to pass unheeded. "Nous nous sommes endormis," wrote the latter in 1867 "dans la satisfaction de nous-mêmes; nous nous sommes détournés du travail, négligeant les efforts, les recherches, les comparaisons, qui créent le progrès." This was the literal truth, and if the penalty France paid was almost more than she was able to bear, it was only what all nations must expect when they surround themselves with a halo of invincibility, and trust to the traditions of the past while they neglect to make fresh efforts for future struggles.

14. There are not wanting signs that public opinion is becoming thoroughly aroused in the British Army, and is striving in various ways to make its influence felt. Questions are arising which cannot be satisfactorily settled except with the active and hearty co-operation of all ranks of the Army. What is most to be deprecated is that the discussion of these questions shall be left entirely to the Press, where, under the cover of anonymous authorship, reckless assertions are made, and false impressions created, which tend to mislead the public mind. In these pages all must have the courage of their convictions, and write with the full knowledge that if their statements are found to be inaccurate or exaggerated they will certainly be challenged. In conclusion, I beg to submit that freedom of discussion is quite compatible with the exercise of the strictest discipline; and it is because I believe the committee will share this opinion, that I have ventured to forward this paper for their consideration, hoping they will extend to it their kind forbearance, and trusting that it has been written with due respect and with proper modesty.

ALDERSHOT,
October, 1880.

THE ORGANIZATION AND EMPLOYMENT OF GARRISON ARTILLERY;

FROM

A PRIZE ESSAY

BY

LIEUT.-GENERAL FERSMAN AND LIEUT.-COLONEL SCHKAREWITSCH,
Imperial Russian Artillery.

TRANSLATED BY

A MEMBER OF THE R. A. INSTITUTION.

UNTIL within the last ten years it has been the custom, in accordance with "Vauban's Method of Attack," to enter upon the establishment of a first artillery position after the completion of the first parallel, and generally the first batteries were made in this parallel.

In the modern attack, the establishment of the first artillery position is antecedent to, and entirely independent of, the throwing up of the first parallel, which latter serves solely for securing the safety of the batteries of the attack situate behind it, and for keeping such ground as has been already taken, as a basis for the subsequent sapping operations.

Many examples are to be found in the history of sieges, where the attacking force has succeeded during one night in opening the first parallel entirely unobserved at a short distance from the place, and in executing such extended works, that on the next morning they had sufficient cover to enable them to hold out against the enemy's fire.

But in addition to the unperceived establishment of the 1st parallel, the modern system of attack requires the construction and arming of as many batteries as possible of the second artillery position in the same night.

Modern improvements have rendered possible the establishment of a battery of the attack in one night, but whether the attacking force can, in the course of one night, construct such a number of batteries as shall give them a decided superiority of fire over the defenders, will depend mainly upon the energy of the latter.

There is in the opinion of the authors no doubt that the unexpected opening of fire upon the defenders from a greater or less number of batteries of the second artillery position—even for a short time—would produce no little disorder and loss amongst the defenders, because the latter should be at this moment engaged in completing their arming against the siege attack.

In order to avoid all detrimental results of a surprise of this nature, the defenders must use their utmost efforts to discern the time when, as well as to discover the place where, the attacking force throws up his batteries at dismounting distance, in order to know how to oppose them.

The time to Arm against a Siege Attack.

In the "Handbook for Officers of the Prussian Artillery" (1877) the following principles are laid down respecting the position of guns for an artillery fight:—

"The moment of opening an effective fire from the garrison guns for the artillery fight, exercises a conclusive influence on the success of the whole defence.

"It follows then, that before the attacking force has succeeded in bringing the artillery of the first position into action, there is a possibility of so hindering the attackers, that the advantage of the initiative may be lost to them, and that the defence may obtain the superiority.

"If, on the other hand, the attacking force succeeds at this important moment in surprising the defenders, and in securing the basis for the attack by opening fire with the artillery of the first position, the most extraordinary efforts will be necessary on the side of the defenders to prevent their being greatly hindered in their necessary defence preparations."

It is therefore obvious that the arming against the siege attack must be already completed before the batteries of the first artillery position (distant from 700 to 1400 mètres from the works) open fire.

While fully acknowledging the authority of the above-named work, the two Russian authors are unable to agree in the views expressed in the above quoted extract, because it appears to them that the power of the artillery of the attack is over-estimated, while that of the garrison is undervalued.

The history of sieges shows that the batteries of the first artillery position are generally of the nature of bombarding batteries, which have not only the actual point of attack under fire, but also another salient, so that it is quite impossible for the besieged to find out the true front of the attack.

Moreover, it appears that in the cases where the batteries of the first position have produced a decisive effect, the place invested was always

very weak in artillery; finally, no case is on record of the attacking force having at the outset so many guns at its command as to be able to hinder completely the prosecution of the work of arming on the part of the besieged. It must be remembered that in the war of 70–71 the artillery of the attack was greatly superior to that of the defence, that, moreover, excepting at Belfort, the guns were placed on the *terrepleine* and fired through deep embrasures—which important differences in the guns, and in their employment by the two contending parties, are hardly likely to occur again. Moreover, the arming of a stronghold can now be accomplished much more quickly than formerly.

After further discussion of this point the authors state their opinion that the batteries of the first artillery position of the attack will in most cases be established unnoticed, but this is of no great importance, for their fire never has any effect on the end of the siege.

As to the time of arming for the siege attack, the authors maintain that the opening of fire from the first artillery position would only cause the defenders to increase the number of guns at the part most exposed to fire, and that the complete arming should be coincident with the opening of fire from the second artillery position. They think that it would be always possible to carry on the arming under the fire from batteries of the second artillery position hurriedly thrown up in one night. The number of probable fronts of attack in a fortress of the present day is not great. Given a certain amount of activity among the defenders, and suppose the not unlikely case that they succeeded in discovering, with tolerable exactitude, the position in which the enemy was making his lodgements, they would be able to guess his intended points of attack with tolerable certainty.

The preparations for arming all these fronts would now be begun as promptly as though the attack on them had actually commenced.

It has been abundantly shown by experience, that beginning these preparations too early results in the greatest disorder and delay.

If the platforms are in good order, and the guns and carriages in close proximity to the positions in which they will probably be required, the arming can be done in a very short time, and without any interruption.

If the arming is carried on during the day under the fire of the besiegers, it must be done under cover of a hot fire from those guns which are already mounted; and those guns which have not been placed in their destined positions must be made as much use of as possible. The moral and physical effect of this was very obvious at Belfort, where even guns on fronts altogether remote from the enemy's attack were enabled, by being turned round, and by the employment of indirect fire, to take part in the artillery battle.

If proper attention be paid by the defenders to established rules, they will, even if the first artillery position have been established without discovery, and fire be suddenly opened from it, be able to oppose it with sufficient strength, and to proceed uninterruptedly with their work.

It may not be amiss to mention in this place a saying of Laurencie's who, as is well known, took a great part in the defence of Belfort. He

sums up all the duties of garrison artillery both before and during a siege in the one word "work," adding "Travailler, c'est à dire remner des pièces, remner des bois, remner du fer, remner des terres, remner enfin quelque chose et s'occuper. Là est la force de l'artillerie de place là est sa puissance là est en même temps sa securité."

The well-timed conclusion of all preparations is of the greatest importance for the successful carrying on of the defence. This can only be expected if the works have been undertaken beforehand, and not left until the time of need to be begun. If from the moment that it appears probable that a fortress may be attacked, the garrison spare no pains, but labour with workman-like foresight to get all things ready, then it will be in a position to take an energetic part in the artillery battle. Mere bravery on the part of the troops, in the absence of discretion and industry, can never warrant the hope of a successful issue. Let us suppose that a brave garrison has been surprised by the appearance of a besieging force, that they undertake their work of preparation for the defence under the fire of the enemy, and succeed in completing them—then comes the question: In what state are they when they open fire? How much loss have they sustained before they could fire a shot? How much energy can fairly be expected of a man of that garrison during the continuance of the siege? How dearly must they have paid for any unskilfulness in manipulation owing to forgetfulness arising from delay. Even in former days, when sieges with smooth-bore guns lasted a long time, every negligence on the part of the defence was very dearly paid for. Now, with modern weapons and strategy, no fortress can be expected to hold out for long against an energetic siege.

Means of Discovering the Enemy's Works.

The defenders gain an important advantage if they succeed in discovering in good time the position of the enemy's batteries, and that of the first parallel. Firstly, because they can hinder the work and cause them much loss by a well directed fire; secondly, because the operations of attack being thus hindered, the defenders have more time to proceed with their arming so as to be ready for the decisive artillery battle.

The defenders must not, however, make too sure of discovering the enemy's works by the means here suggested, but must proceed with their preparations as though they were sure to fail in this discovery. In this way alone can they be safe from surprise and disorder.

The following means may serve for the discovery of the works of the attack at night:—

1. Lighting up the ground in front.
2. Sorties.
3. Establishment of a chain of outposts.
4. Secret observation of the enemy.

The electric light was employed for illuminating the ground in front both in the American civil war and in the campaign of 70–71. This method succeeded as often as it failed. If any object lay between the lighting apparatus and the position which it was desired to illumine, then this latter was so much in shadow as scarcely to be visible. This happened, for example, at the siege of Paris, when it was desired to illumine the works of the south attack. On the other hand the defenders succeeded by means of the electric light in discovering the works near St. Cloud, whence they dislodged the enemy. In Belfort there were several excellent opportunities for utilizing the electric light, but in that place the reflector of the apparatus received an injury, for the repair of which there were no means at hand. The defenders were therefore deprived of the use of it. It appears, therefore, that the usefulness of this method of illumination is hindered sometimes from external and sometimes internal causes.

Light balls, &c., were, so far as we know, not used at all in the war of 70–71. They were used in the defence of Sebastopol, but no results worth mentioning were obtained by their use. They could generally only be used for short distances, in order to light up the object aimed at. The rocket light balls lately introduced in the German artillery hold out greater hopes of success in lighting a considerable extent of ground from above. Of their practical value little can be said with certainty, owing to the want of sufficient experiments with them.

Lt.-General Fersmann and Lt.-Col. Schklarewitsch are of opinion that sorties for the purpose of discovering the enemy's works are altogether useless. Their success depends entirely on good luck, they cause an enormous strain on the troops of the defence, and expose them to the chance of terrible loss.

The establishment of a line of outposts is in general of great value in the discovery of the enemy's works, yet the experience of war shows that this particular means of exploring the works of the attack does not hold out much hope of success, for the besieging force also pushes forward a line of outposts under cover of which his works are carried on. If the outposts of the defence wish to attain their object, a collision with the hostile outposts is inevitable. The skirmishing fire resulting from this may cause a false alarm and mislead the defenders, while the attacking force pursues its works unmolested, while the defenders receive conflicting intelligence as to the position of the enemy's works.

Secret observation of the enemy was used with great effect by the defenders during the siege of Sebastopol. This was done in this wise. Small detachments were sent out on favourable nights to selected points, on the ground which had been thoroughly surveyed, whence the enemy's movements could be closely observed. With every detachment there was a gunner and sapper. The former observed the direction whence the enemy's shots proceeded, the latter endeavoured by different indications to discover the enemy's works. Notwithstanding the great advantages obtained by this mode at Sebastopol, it has not been subsequently much used. Further experiments are necessary to show whether or no this method is to be recommended

for modern sieges. Very intelligent men, experienced in that kind of work are required in these detachments. These men must be trained in peace time during manœuvres illustrating the attack and defence of fortresses. These manœuvres are especially important for garrison artillery, for the clearing up of many points connected with sieges.

Operations after Discovery of the Enemy's Works.

The discovery of the position of the enemy's works will be of little use to the defenders as far as night-firing is concerned, unless the ground in front can be lighted, so that the guns may be aimed and the effect of the shots observed. There remain two courses open to the defenders, either to lay the guns in the direction of the works, according to plans of the country, and to fire at random, or to make sure of not wasting all the fire on some unimportant work, to vary the direction of the guns, so as to keep a certain portion of the ground in front under fire.

If the data obtained from the maps be not correct, there is the risk of wasting all the ammunition in the first case, and a great part of it in the second. Let us suppose that the means of illumination at hand be in a state of efficiency, and that the defenders have in some way discovered the position of the besieger's batteries, and let us pass on to a consideration of the employment of the artillery at this juncture.

The garrison artillery should have the two following objects in view:—

a. To injure the works and to hinder their completion.

b. To keep up an energetic fire on all convoys bringing stores of any kind, thereby to prevent the arming of such batteries as are completed.

For the attainment of the first of these objects, the whole of the fire of the fortress must be concentrated on one part of the works, while the second requires a sweeping fire over the whole ground in front. Here the authors think it necessary to explain that in the expression "the whole fire of the fortress," they refer only to those guns from which direct fire can be poured on the enemy.

Night firing, when the object aimed at is not visible, is often necessary in sieges.

In order that there should be any chance of this being successful it is absolutely necessary that practice at the object aimed at should have been made on the preceding day. But in case (*a*) this is altogether out of the question, for under the most favourable circumstances it would be tolerably late at night before the position of the enemy's works could be discovered, and it is often necessary to correct the laying by means of an observer standing at a greater or less distance from the guns. Without asserting that such fire would be altogether

ineffective, we think it would be better under these circumstances to employ all the guns in the attainment of object (*b*).

The range will be best ascertained by means of common shell, and then shrapnel will be used until the parapet shelters the men at work. We would also recommend that some of the guns should always fire common shell, as these are better for regulating the range than any observation; moreover, it is very difficult to decide whether shrapnel or common shell is more effective at night. If, in spite of the fire, the batteries of the attack are so far completed as to be ready for their armament, and if the defenders, and the convoy with the guns, &c., come into the illuminated zone, then some of the guns should fire shell at the batteries, while the rest, and in fact any guns in the place which can be brought to bear upon the convoy directly or indirectly, should keep up a hot fire of common and shrapnel shell. So that although the indirect fire may produce but little effect compared to the numbers of shots fired, yet the whole zone through which the convoy passes will be kept under fire.

If any of those positions in which the enemy's works are suspected to be are not illuminated, or if the defenders possess no means of illumination, then it is by no means advisable to engage in the bombardment of the enemy's works, for even in the best provided fortress, and if the exact position of the enemy's batteries be known, there is always a possibility of the ammunition running short. Under these circumstances it appears most advisable for the defenders to redouble their efforts to prepare all things for an effectual opposition to the opening fire of the attack on the following morning.

The Position of the Guns of the Defence.

While defenders are employed in the bombardment of the works of the attack, the arming of all that front which can take any part in the fight must be pushed forward with the greatest rapidity. On that front all the heaviest guns in the place should be mounted if possible in the course of that night.

Let us now consider the arming for the regular artillery fight.

a. The mode of placing each gun.
b. The distribution of the guns in the place.

In former days the guns intended for silencing the siege batteries were all placed without any shelter on the rampart. Now-a-days only part of the guns are placed on the ramparts; the remainder are partly mounted in the covered way, partly in batteries in front of and near the works, and partly completely under cover in the place.

All those mounted on the main rampart are protected most carefully by traverses, and fire through embrasures.

In order to determine the best mode of mounting guns, experiments have been made, on different practice grounds in Russia, by firing from siege batteries on guns mounted in the four following ways :—

(*a*) Guns mounted on overbank carriages.
(*b*) Guns firing through embrasures.
(*c*) Guns placed a known distance behind the parapet, and firing through shallow embrasures.
(*d*) Guns mounted in the covered way, behind very shallow embrasures cut in the glacis.

At the practice ground at Warsaw experiments were made with the 9-pr. and 24-pr. bronze guns, at a range of 940 mètres, with the following results :—

For the dismounting of a gun on an overbank carriage, ten rounds from the 24-prs. were necessary; these also placed three men of the detachment *hors de combat.*

Ten rounds from the 24-prs. were also fired at the gun behind the deep embrasure. These killed or wounded the whole gun detachment, and destroyed the embrasure.

Fifty-two rounds, partly from the 9-prs. and partly from the 24-prs., were fired on a gun mounted in rear of a shallow embrasure; these killed or wounded the whole gun detachment, and greatly enlarged the embrasure (·91^{m} in depth, 3^{m} in breadth).

In order to dismount a gun in the covered way behind a shallow embrasure, 75 rounds (partly from the 24-prs. and partly from the 9-prs.) were necessary.

From the results thus obtained, the experimental committee drew the following deductions :—

To dismount guns either on overbank carriages, or firing through deep embrasures, requires but a short time and comparatively few rounds.

To damage a gun mounted at some distance from the parapet, and firing through a shallow embrasure, or mounted in the covered way, is a much longer operation, and in general cannot be done until the covering parapet is breached, and the gun altogether exposed. The farther back a gun is from the parapet the more important it is that it should be covered from the enemy's fire—as in this case the danger of the gun detachment is much greater.

The most secure position is behind the glacis in the covered way, because direct fire is almost impossible against guns so placed, and it is so difficult to see the effect of the shots. So that it takes a very long time and a great many projectiles to damage guns mounted here.

Similar results were obtained at other practice grounds. General Todleben has made the following observations in reference to them :—

"It is not desirable to mount all the guns on the ramparts. Only a small portion of the armament should be so placed. The rest of the guns should be mounted in the covered way, and within the works.

By placing them in this manner, and by the use of high traverses to guard against enfilade, the artillery of the garrison will be in a condition to oppose an energetic fire to that of the siege artillery."

This assertion has been contradicted by many professional men, who based their opinion upon former experiences, but who probably had overlooked the fact that until now it has been an almost universal custom to mount all the guns of a garrison on the principal ramparts.

The following suggestions of Todleben's have been put in practice—namely, in Russia, in the arming of fortresses constructed on various different systems.

Only one gun was mounted near each traverse, the remaining guns of the fortress were carefully covered. In the interior of the works, cover was thrown up for every two guns at the most. These covering parapets are so far distant from the rampart that the mean trajectory from the siege batteries at, say 650^{m} from the crest of the glacis, must be at least 1·8^{m} higher than the crest of the main parapet.

Such a disposition of the guns possesses the following advantages:—

(*a*) The number of guns which it is possible to mount is no less than before.
(*b*) The guns and detachments are well under cover.
(*c*) The arming will be made much easier, since only a part of the guns have to be taken up to the chief parapet.
(*d*) Owing to the reduction in the number of guns on the main rampart there will be room in case of need for the posting of infantry.

The use of guns under cover in the side of works, with indirect fire, was first tried with advantage in Russia, in the Polygon, at Warsaw, in 1867. Considerable use of this method was made at Belfort. The French had 40 guns mounted in this way, and they remained uninjured during the whole period of the defence.

If the place is encircled by forts, what has been said above applies to them also. The chief strength of the artillery is transferred to them.

As soon as the besieger has begun his works, the intermediate batteries nearest to the threatened fort should prepare for the defence, for they have to sustain the chief part in the artillery fight. At the same time all the guns of the principal *enceinte* which can be of any assistance to the forts should be prepared. The only exceptions should be those guns which, by reason of their great distance from the siege works, would have but little prospect of injuring them; or those whose nature does not hold out much hope of effective fire; or, lastly, the reserve, which should be kept for supplying the places of dismounted guns.

The forts can never sustain for any length of time the concentrated fire of all the siege batteries, as, owing to their great distance from one another, they can afford each other but little support. This unequal battle can only be carried on with the assistance of intermediate batteries.

According to the orders for the Russian army the intermediate batteries, made in peace time, are not to be armed until the attacker

begins to make his siege batteries. In Prussia these intermediate batteries are not made in time of peace, and are in fact not begun until the probable front of attack is known. Care must be taken with regard to the position of intermediate batteries, that they should be entirely with the encircling line of forts, so as to be protected from assault, and not interfere with the fire of the fort. The main principle which determines the selection of points for the intermediate batteries has, however, yet to be stated.

It is that each battery should have under fire the whole of the ground in front up to the effective fire of its guns, and that the communications from the forts to the principal *enceinte* should be secure. The communications must be made by trenches, if the nature of the ground does not admit of their being otherwise covered. It is scarcely necessary to mention that the batteries should be placed so as to be concealed as much as possible by the ground in front, but in regard to this, it must be always borne in mind that the effect of shots can not be satisfactorily observed at any considerable distance from the battery. For the protection of these batteries from assault, there is the cross-fire from the forts on the ground in front, and the fire from light guns in trenches in line with and in front of these batteries.

Especially important points of this line of defence might be strengthened by fortification, and held by regular garrisons.

In one word, the defenders must prepare their intermediate batteries as though they wished to besiege the batteries of the attack. Only in this way can they enter upon the artillery fight with any hope of a successful issue.

ZAIMUKHT EXPEDITION,

UNDER BRIGADIER-GENERAL J. A. TYTLER, V.C., C.B.

BY

CAPTAIN G. T. CARRÉ, R.A.

A short account of the capture of Zawa, the stronghold of the Zaimukht's, on the 13th and 14th December, 1879, may be interesting to some of my brother officers, as it was the first occasion on which the 7-pr. jointed gun was used against an enemy.

The resistance of this very strong natural position was but feeble, the arms of the Zaimukhts consisted only of knives, jezails (long barrelled flint guns), matchlocks, and a few Enfields, which could not compete with our long-ranged weapons. Our loss was small—one officer and three sepoys killed and a few wounded; the enemy's was about 200.

The capture of the position with so few casualties was mainly due to the effective fire of the jointed guns, their superiority over the 7-pr. (200 lbs.) being very marked in range, accuracy, and shrapnel fire. General Tytler's skilful dispositions were particularly happy in affording opportunity for the display of these advantages; and the manner in which his orders were carried out, and the guns worked over most difficult country by Major Haughton, R.A., reflected credit on the battery.

Description of Position.

The strength of Zawa lay in its natural defences. It consists of a group of five villages, lying in a hollow plateau or basin, approachable through a winding gorge six to seven miles long and, at first, 100 yds. wide, but narrowing gradually until at length the cliffs meet overhead, forming a cave or tunnel, through which the stream from the plateau has cut its way. A short distance from the head of the defile, an

alternative path ascends the left side of the gorge to the crest of the ridge; but, although it avoids the tunnel, it is utterly impracticable for mules and can only be scaled by one man at a time. To this stronghold the inhabitants of the Zaimukht valley, when threatened by an enemy, had been accustomed to send their families and property, and, until the 14th December, 1879, it had always defied capture.

The Attack.

2 7-pr. jointed guns.
1/8, R.A., 3 officers, 20 N.C. officers and men.
85th K. L. I., 720 officers, N.-C. officers and men.
4th P. I., 600 officers, N.-C. officers and men.
20th P. N. I., 540 officers, N.-C. officers and men.
29th P. N. I., 600 officers, N.-C. officers and men.

At daybreak on 13th December, a force, as per margin, marched from camp at Chinarak towards the village of Ragha. At point *B* the jointed guns came into action against detached bodies of the enemy crowning the opposite heights, at a range of 750 to 800 yds. Under cover of their fire the right attack, consisting of two 7-prs., 200 lbs., Kohat battery, some companies 85th K. L. I., and 29th P. N. I., the whole commanded by Colonel J. H. Gordon, C.B., advanced against the enemy. The first crest was taken with slight opposition, and the attack was continued against a "sunga" (stone breastwork) higher up, the 7-pr. jointed guns throwing shells into it, over the heads of the skirmishers, from point *B*, a distance of 1990 yds., as ascertained by Watkin's range-finder. This breastwork was stormed, the enemy carrying off their dead and wounded, and taking up a fresh position on the line *D, C, G*; pools of blood, on the ground they had vacated, testified to the deadliness of our fire. The troops pushed forward over a succession of ravines and ridges, each higher than the one preceding, and all defended by sungas. As soon as Colonel Gordon's attack was sufficiently developed, General Tytler descended from point *B* and led his main body up the gorge. It consisted of two 7-pr. jointed guns, one company 85th K. L. I., 4th P. I., and 20th P. N. I. As he advanced, the enemy opened a desultory fire from the rocks above. To drive them from the heights the guns were brought into action on the sides of the gorge, firing across it. A few shell on each occasion were sufficient to dislodge them; our infantry occupying their positions in succession, and working steadily from crest to crest until they reached the village of Bagh, where pickets were thrown out and the troops bivouacked, communication being maintained with the right attack on *E*.

Early on the morning of the 14th the advance was continued, Colonel Gordon's party taking the position *D, C, G*, and at one point coming into hand-to-hand combat with the defenders. Meanwhile, a large body of the enemy had occupied a high hill, completely enfilading and commanding the gorge through which our left was moving. The 7-prs. were brought into action in the bed of the stream, firing with a

luckily guessed range of 1600 yds. and elevated to 20°. The first shell burst right in the middle of the enemy, taking them completely by surprise, as at such a distance they had not thought of taking cover, and, the projectile travelling quicker than sound, they were unaware till it fell that the gun had been fired. A splendid chance was offered while they crowded to pick up their dead and wounded, but, unfortunately, the unevenness of the ground prevented the other gun being sufficiently elevated until they had begun to withdraw, when its shell swept the face of the hill, and they hastily fled from the position.

The 4th P. I. and the 20th on the right, advanced as far as the village of Kotkai. In front of the right, the enemy had fallen back to the strong line *x*, *y*, *z*, where, to the number of 2000 to 3000, they appeared determined to make a stand. The crest of the hill afforded them such good cover, that the direct fire of the short 7-prs. with Colonel Gordon's force could not touch them at a range of 2000 yds., but the jointed guns gained a point beyond Kotkai, from which they were able to enfilade the reverse of the crest at a range of 2500 yds., and a dozen shells caused them to move, and they retired towards *z* and dispersed. General Tytler now ordered the whole of the 85th K. L. I. from the right attack to join him at the gorge below *M*. Here the enemy made a last stand, but the 85th stormed the crest, killed 20 of the defenders, and occupied Zawa.

Description of 7-pr. R.M.L. jointed gun.

Length,	nominal	68·25 in.
	total	70·45 "
	breech portion	25·7 "
	muzzle "	45·5 "
	bore	66·5 "
	rifling	55·5 "
Weight,	breech portion	200 lbs.
	muzzle "	200 "
	total	400 "
Rifling,	number of grooves	8
	width	0·5 in.
	depth	0·05 in.,

spiral increasing from 1 in 80 at breech to 1 in 30 at muzzle, commencing at 11·7 ins. from bottom of bore.

Powder chamber enlarged to 2·56-in. diameter. Tangent scale of steel, reading from 0 to 15°. The head of the scale has a slow motion arrangement for reading to minutes, and a deflection leaf.

Beneath the sighting notch is a small hole for laying, in combination with trunnion fore-sight cross wires.

Fore-sight screwed into trunnion ring, hog-backed, with cross wires.

Projectiles.

Shells, studless, fitted with gas checks,	common,	filled with 4-oz. bursting charge	7 lbs. 6 oz.
	Shrapnel,	filled with 88 mixed bullets—48 of 40 to lb., 40 of 55 to lb.; $\frac{1}{2}$-oz. bursting charge;	7 lbs. 6 oz.
Shot, case, filled with 78 bullets, $16\frac{1}{2}$ to the lb.			7 lb.

Charge, 1 lb. 8 oz. R. L. G^2, in silk cloth.

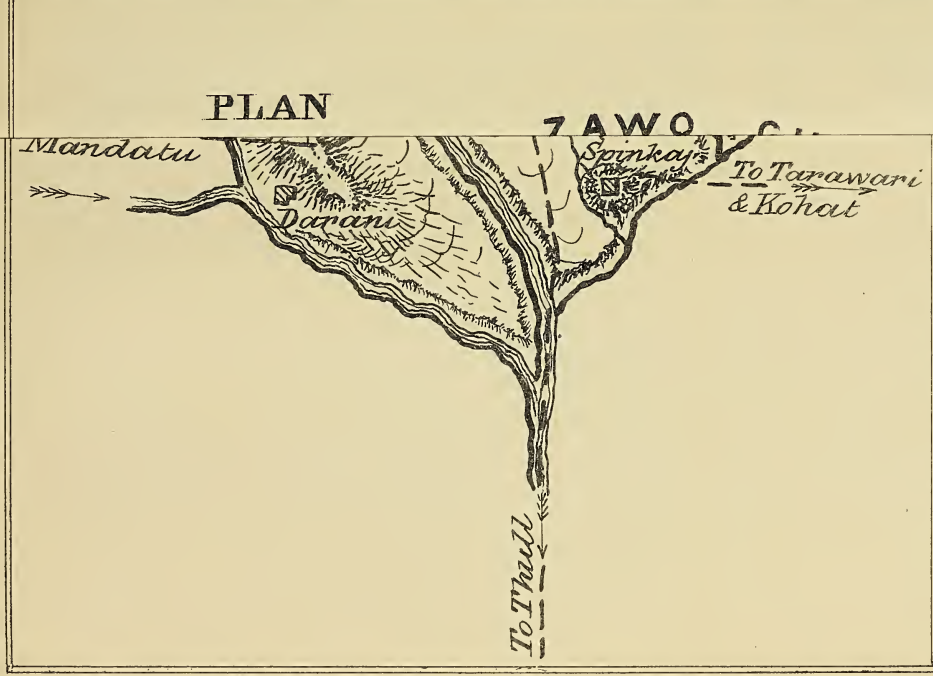
Fuzes.

R. L. percussion, Mark II.
Armstrong, special, combining time and percussion, 9 secs.

The gun is carried on five mules:—

		Weight.
1.	Muzzle portion	200 lbs.
2.	Breech "	200 "
3.	Carriage	177 "
4.	Axletree, elevating gear, and axle-boxes	237 "
5.	Wheels	197 "

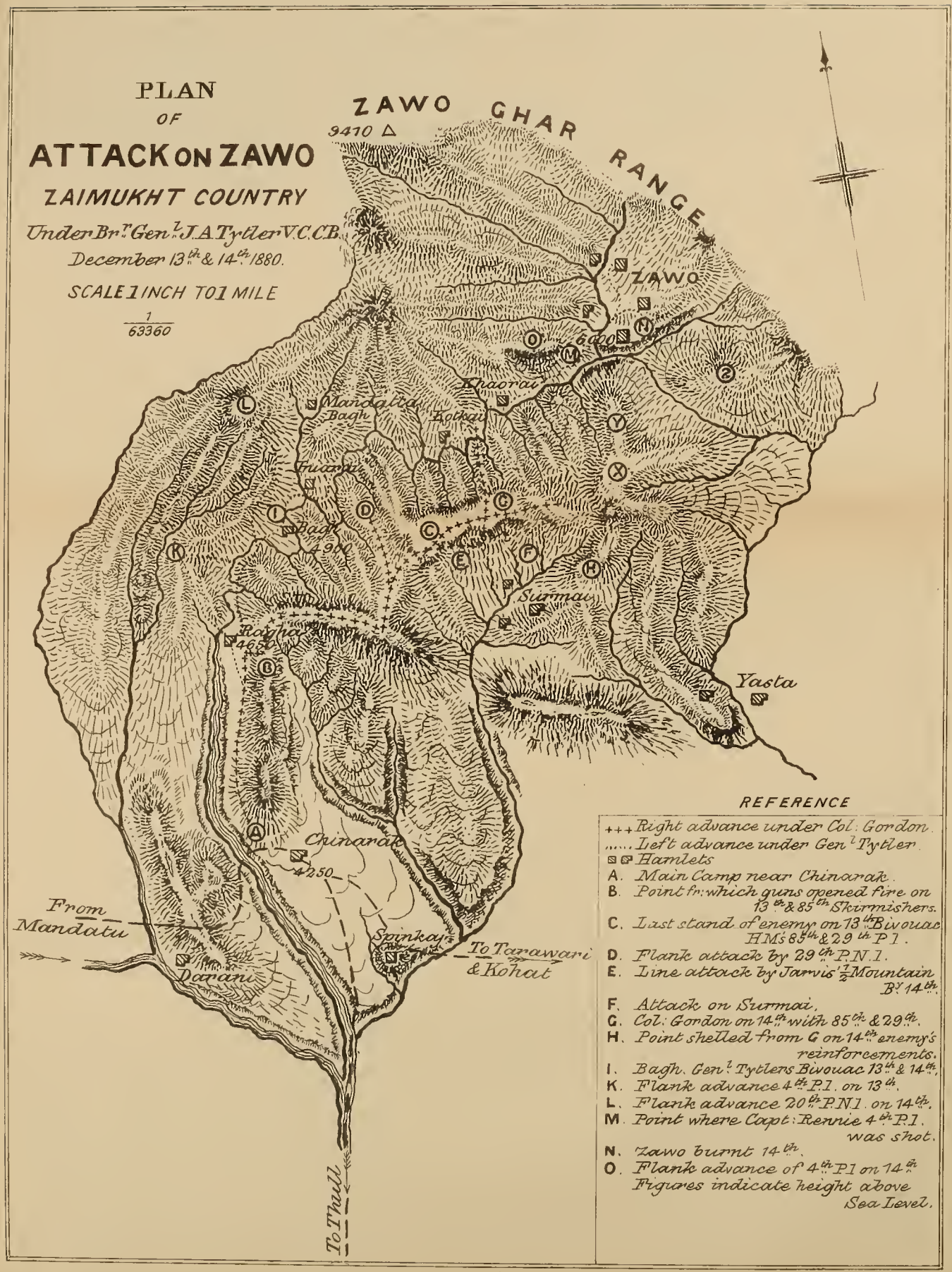
100 rounds per gun carried on six mules, with 4 rounds of case in axle boxes; contents of each box—5 shrapnel; 2 common; 1 case.



HMs 85th & 29th P I.

D. Flank attack by 29th P.N.I.
E. Line attack by Jarvis' ½ Mountain Bty 14th.
F. Attack on Surmai.
G. Col: Gordon on 14th with 85th & 29th.
H. Point shelled from G on 14th enemy's reinforcements.
I. Bagh. Genl Tytlers Bivouac 13th & 14th.
K. Flank advance 4th P.I. on 13th.
L. Flank advance 20th P.N.I. on 14th.
M. Point where Capt: Rennie 4th P.I. was shot.
N. Zawo burnt 14th.
O. Flank advance of 4th P.I on 14th

Figures indicate height above Sea Level.


PLAN
OF
ATTACK ON ZAWO
ZAIMUKHT COUNTRY
Under Brt Genl J.A Tytler V.C.C.B.
December 13th & 14th 1880.
SCALE 1 INCH TO 1 MILE
1/63360
ZAWO GHAR RANGE
9410
ZAWO
6400
Khaorai
Kotkai
Mandatta
Bagh
Inuara
Bagh
4900
Surmai
Rajha
4650
Yasta
Chinarak
4250
From
Mandatu
Spinkai
To Tazawari
& Kohat
Danani
To Thull
REFERENCE
+++ Right advance under Col: Gordon.
..... Left advance under Genl Tytler.
Hamlets
A. Main Camp near Chinarak.
B. Point from which guns opened fire on 13th & 85th Skirmishers.
C. Last stand of enemy on 13th Bivouac HMs 85th & 29th P I.
D. Flank attack by 29th P.N.I.
E. Line attack by Jarvis' 1/2 Mountain By 14th.
F. Attack on Surmai.
G. Col: Gordon on 14th with 85th & 29th.
H. Point shelled from G on 14th enemy's reinforcements.
I. Bagh. Genl Tytlers Bivouac 13th & 14th.
K. Flank advance 4th P.I. on 13th.
L. Flank advance 20th P.N.I. on 14th.
M. Point where Capt: Rennie 4th P.I. was shot.
N. Zawo burnt 14th.
O. Flank advance of 4th P.I on 14th
Figures indicate height above Sea Level.

NOTES ON THE LAYING OF GUNS BY MEANS OF A TELESCOPE.

BY

COLONEL de COSSIGNY,

TRANSLATED FROM THE FRENCH BY

CAPTAIN E. WALSH, R.A.

THE long ranges at which it is often necessary to open fire, as well as the care taken by the enemy to mask his guns and his troops, do not always permit gunners to distinguish their object clearly, and the necessity for some optical apparatus in connection with the sights is daily becoming more and more pressing. Ordinary sights insufficient under certain conditions of modern warfare.

In order to be convinced of this truth we need only observe how frequently battery commanders allow the Nos. 1, or "layers," to look through the battery telescope before proceeding to lay their guns.

At ranges exceeding 2000 mètres, if there is not a very strong light on the object, if the object does not stand out clearly on the horizon, or if the enemy's batteries and troops occupy ground cut up by hedges, &c., we can distinguish nothing with the naked eye, and our gunners must either lay their guns approximately in the required direction, or on the smoke of the enemy's pieces, which is a very vague sort of mark.

During the last grand manœuvres executed by the 18th Corps, the battery commanders ascertained that even at ranges of 1500 mètres it was impossible to distinguish the enemy's batteries when they were well placed. Besides, to enable a battery commander to find his range rapidly and surely, the first condition is that the six guns be not only laid on the same point, but also that they be laid in the same manner; now, in practice, some men always lay high, others always low. With the system which I propose, if all the instruments of the battery, or even of the regiment, are regulated by the same man, we can obtain an *absolute regularity of fire*. On the other hand, if we consider how difficult it is to find good "layers," whose eyes do not soon become tired, we must admit the very great importance of having a means by which a man without any particular aptitude, and even with bad sight, can lay a gun at any range with mathematical exactitude. Experience gained during recent manœuvres. Importance of laying every gun in exactly the same manner. Uniformity and accuracy in laying secured by the telescopic apparatus.

Before describing the instrument which I propose, it may be well to state the manner in which guns are laid with the tangent-scale and moveable sliding leaf, for it is partly on the arrangement of these sights that my system depends. Laying guns with the service sights.

The elevation having been given according to the estimated range—the altitude of the place, and the atmospheric conditions—and the deflection according to the tables of "derivation," and with the proper allowance for the force and direction of the wind, the line of sight is directed on the object with more or less accuracy. The gun is then

fired, and the projectile either hits or misses the mark. It generally misses, either owing to error in the deflection given, or in judging the range, or any other cause connected with the cartridge, the projectile, or the gun. The "layer," or the No. 1, must then endeavour to correct the deflection; to obtain this correction he should lay the gun on the same point as before, and, *as far as possible, in the same manner*, and then move the deflection scale until the eye-hole, the fore-sight, and the point of impact of the projectile are in line. If the "layer" has taken the *same kind of sight* on both occasions, he will have rectified the deflection. But it often happens that during this operation a gunner does not lay twice in the same manner, and in that case, of course, the correction is not exact.

Thus, for example, a gunner laying on the object, *B*, has directed the line of sight on the point, *b*, two mètres to the left, and the first graze of the projectile is at *P*, six mètres to the left of the object. In this case the real correction should be $6^m - 2^m = 4^m$.

But let us suppose that the gunner, thinking he is laying in the same manner, lays the next round on *b'*, three mètres to the right of the object; to correct his deflection he takes the distance between *P* and *b'*, that is $6^m + 3^m = 9^m$. Thus he makes an error of $9^m - 4 = 5$, and if he lays the next round with mathematical accuracy he will strike at five mètres to the right of the object.

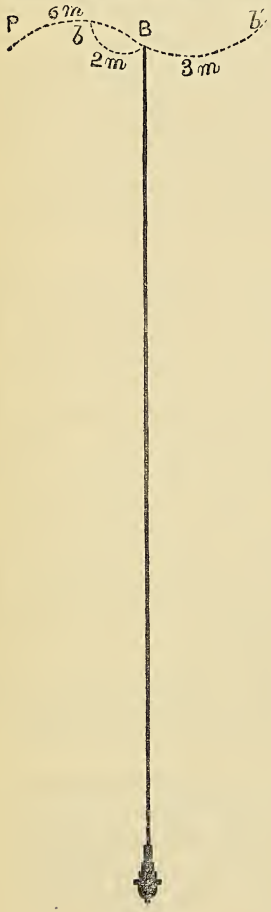


Fig. 1.

Thus, if the first graze is at *P* (35 mètres to the left of *B*), by laying with the same elevation and deflection as before on the object, *B*, but using the telescope, I shall place the gun in the same position as when the first round was fired. Then, if I move the deflection-scale so as to bring the optical axis of the telescope on *P*, the point of graze, and afterwards lay the gun, with the deflection thus found, on the object, *B*, the second shot—other conditions being the same—will fall in the direction of the object.

It is necessary and sufficient, in order to correct the deflection with a gun that shoots straight, to lay the first two rounds *in the same manner*.

Suppose, for example, that wishing to strike the object, *B*, in Fig. 2, I lay the first round, even very badly, and direct the line of sight on *b*, 25 mètres to the left of the object. If I can, before firing, and without moving the gun, place upon the fore-sight and tangent-scale a telescope with its optical axis directed on the object, *B*, and capable of being always directed with accuracy, I can correct the error in direction.

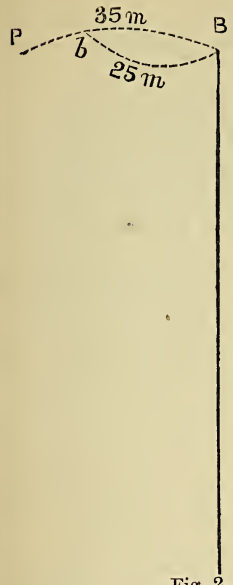


Fig. 2.

It is in order to show the extreme importance of laying the first two rounds in precisely the same manner, that I have been so particular in describing the manner in which the deflection is corrected.

We may say then, that the best "layer" is he who groups his shots best. A gunner who always lays lays 20 mètres to the right of the object, may have his first shot to the right, but when the deflection has been accurately corrected after the second round, all his subsequent shots will be in the right direction. He is very superior to one who always lays near the object, with an error of 3 or 4 mètres. If the deflection has not been accurately corrected, the grouping of the shots will be, not round the object, but round a point on the prolongation of the line of sight, which in this case has not been directed on the object.

Uniformity in laying more important than moderate accuracy.

INSTRUCTION IN THE USE OF THE TELESCOPIC APPARATUS FOR LAYING FIELD GUNS OF 90^{mm}, 80^{mm}, 95^{mm}, AND 7.

The apparatus, of which sections are subjoined, is mainly composed of a telescope with moveable cross-hairs fixed by means of six screws on an iron rest about 1 mètre long; the lower face of the rest is provided at one end with a spring made to fit accurately into the hole at the top of the "Broca" foresight of the 90^{mm} gun. The dimensions of this instrument admit of its being used also with guns of 80^{mm}, 95^{mm}, and 7.

General description of the telescopic apparatus.

The other extremity of the "rest" has a projection underneath in the shape of an inverted V, which serves to keep it steady on the eye-piece of the tangent-scale.

The telescope screwed on its rest is placed in a box which, on the line of march, is carried on the foot-board of the limber, close to the ammunition-boxes, but separated from them by two springs which serve to deaden the shocks occasioned by the jolting of the carriage.

Carriage of the instrument on the march.

To place the instrument on the gun, the point of the spring is passed through the hole in the fore-sight and pushed gently forward until the heel of the "rest" comes in contact with the fore-sight, the inverted V at the other end of the "rest" will then fit on to the head of the tangent-scale.

Placing the instrument on the gun.

To remove the instrument the spring is slightly pressed, and the "rest" drawn back till the iron point is disengaged from the orifice of the fore-sight.

Taking it off.

TO REGULATE THE INSTRUMENT.

Regulation of the instrument.

It is necessary to regulate an instrument for use with each gun. For this purpose the gun is laid in the ordinary manner by a good marksman with the naked eye, on a very clearly defined object; the telescopic apparatus is fitted on the gun as described above, and the cross-hairs are moved by means of two mill-headed keys until their intersection is projected on the object.

Mathematically, the axis of the telescope being 4^{cm} above the line of sight, the intersection of the cross-hairs should be directed on a point 4^{cm} above the centre of the object aimed at. The optical axis of the telescope is then parallel to the line of sight, and will remain parallel to it as long as the relative positions of the telescope and its "rest" are unchanged, so that the instrument is regulated once for all for its own particular gun. All corrections in shooting must now be made with the tangent and deflection scales, without ever using the mill-headed keys, which should be replaced in the box as soon as the regulation has been completed.

Laying a gun with the telescope.

To lay a gun at any range—the proper elevation and deflection having been given in the usual manner—the instrument is placed on the gun, which is then laid with the telescope instead of the ordinary sights.

Firing at an invisible object.

Cases may occur during a siege where it is necessary to direct a plunging fire on an invisible object. To use the telescope in cases of this kind it must be removed from its normal position on the "rest," and fixed on the other end so as to look backwards from the foresight, and act as a "collimator."

Tests of accuracy.

It may be well to indicate a few experiments which appear to prove most conclusively the accuracy of the instrument.

1. If a gun be laid with the telescope on the centre of a target one mètre in diameter, at a range of 4000 or 5000 mètres, the instrument may be taken off and replaced a great number of times, but the intersection of the cross-hairs will always be found directed on the target.

2. If a gun be laid with one of these instruments, which is then removed and replaced by another, the second telescope will be found to point in the same direction as the first, or, if not mathematically so, at least without any sensible deviation. One, therefore, acts as a check on the other.

3. If one of these instruments be carried on a limber for several days over rough ground, and afterwards subjected to any of the foregoing tests, it will be found to give the same results as before.

4. If a marksman lays 40 rounds in succession with the naked eye, after about 15 or 20 rounds his eye will begin to get dim, or at all events tired, whereas with the telescope he may go on laying the gun for five hours without inconvenience.

5. In laying with the naked eye the deviations are 10 or 15 times greater than with the telescope, as I ascertained in the case of 156 marksmen of the regiment. The results obtained in the 1st battery

are appended. This battery is selected merely because it is first on the list, and the results are analogous in all the others. If the object to be fired at is not clearly defined, as it often happens on service, the deviations in laying with the naked eye are much greater, and it is in a case of this kind especially that the advantage of the telescopic apparatus can be best appreciated.

6. With the telescope an inexperienced man can lay a gun as well as a very good marksman, or in other words, every gunner becomes a marksman, and every man, however bad at laying with the naked eye, can make as good a score with the telescope as an excellent marksman can without it.

7. A gun can be laid just as quickly with the telescope as without it. The following number of rounds were fired from one gun :—

110	rounds in	1 hour 5 mins.
"	"	"
"	"	1 hour 30 mins.
80	"	1 hour.

See the report of the Tarbes Commission, dated 25th September, 1876.

8. With the telescope we can ascertain the effects produced by our fire at any range. These instruments magnify 12 or 15 times, so that with them one can see as well at 2500 mètres as at 200 or 300 with the naked eye.

9. The instrument being regulated in such a manner that one cross-hair shall be horizontal when the gun-wheels are on the same level, one can see at once by observing the position of the cross-hairs, whether one wheel is lower than the other; now, when the wheels are not level, the projectile not only falls on the side of the lower wheel, but it also falls short—a fact which is frequently lost sight of.

The telescopic apparatus can also be used with guns of 138^{mm}, and with rifled howitzers of 22^{cm}, but owing to the sights of these pieces being differently constructed from those of field guns, certain modifications are required in the form and position of the "rest." These details are omitted here, the principle being the same in every case.

FURTHER VERIFICATION.

Verification.

Having laid a gun with the telescope, I fixed tightly in the bore a cylinder carrying a vertical rod, with another telescope at the top working on a knee-joint. I then brought the cross-hairs of the second telescope exactly on the point at which the first was directed and clamped with the screw of the knee-joint. Thus I had two visual lines converging on a point 4000 mètres distant. I then removed the first telescope, and, having disturbed the position of the gun, replaced the instrument, and laid again on the same object. The intersection of

the cross-hairs of the second telescope was still found to be projected on the same point. Now this second telescope, being rigidly connected with the gun, I may fairly conclude that the instrument which I use for laying gives the same results as if it were invariably fixed on the piece, that its axis is not deranged, and that I can replace it after firing in the same position as before.

This was the important point, for it was necessary to remove the instrument before firing the gun, otherwise it would have been broken, or at least deranged by the shock of discharge.

Independent movement of the eye-piece.

The eye-piece of the telescope can be easily moved so as to suit good or bad eye-sight, and this operation does not affect either the laying or the regulation of the apparatus.

If a man has very bad sight, by retaining his eye-glass or spectacles, he will be able to use the telescope when it has been adapted for average eye-sight. Out of 112 men in a battery I only found five who could not see distinctly with a telescope arranged to suit the eye-sight of an ordinary marksman.

It is quite possible to use a single apparatus for several siege pieces of the same nature. Having regulated the instrument for No. 1 gun, it is placed on each of the others in succession, *without moving the cross-hairs*. The elevation and deflection should be corrected so as to bring the "optical" line of sight parallel to that obtained by the marksman, or, in other words, bring the intersection of the cross-hairs on the object on which the gun is laid.

I think, however, that it would be preferable to have a separate apparatus for each piece, as in the case of field guns.

ACCURACY COMBINED WITH RAPIDITY.

Competition in "laying" only.

In the course of four competitions for rapid firing, I either laid myself, or caused to be laid, 400 rounds on objects invisible to the naked eye, at ranges of 4000 to 6000 mètres, against a marksman laying with the naked eye, on a white target, at a range of 200 mètres, and my results were very superior to his, notwithstanding the unfavourable conditions.

Competition practice for precision.

In practice for precision, I had one gun laid with the telescope at a range of 2,500 mètres, against three others firing at 200 mètres range, and laid on white targets with the naked eye, and the rectangle which I obtained was four times smaller than theirs.

More accurate traversing gear required.

In fact, no error in the laying of a gun is possible as far as the telescope is concerned, though some difficulty may arise in obtaining sufficient nicety in traversing with the handspike. The only instruction which a marksman would require is the correction of elevation and deflection, and it is now generally admitted that this operation would always be made by the No. 1 of the subdivision.

Corrections to be made by No. 1.

There is no difficulty in teaching men the ordinary use of the instrument, indeed, I have found that 10 minutes explanation was quite sufficient even with the least intelligent. Use of instrument easily acquired.

This apparatus also serves as an accurate check on the laying of guns at the regimental aiming drill. If a gunner always lays in the same manner with the naked eye, then if the telescope is placed in position it will be found that the intersection of the cross-hairs is always projected on the same point. Thus he may be shown in an indisputable manner whether he is a good or a bad marksman. Application to purposes of instruction.

This instrument may be usefully employed by committees for ascertaining the comparative value of different guns, for all errors in connection with the laying are sure to be eliminated. Use by ordnance committees.

Finally, if the telescopic system of laying guns were unreservedly adopted, the apparatus might be greatly simplified by introducing a uniform pattern of sights on all guns. Thus, by generally adopting a "Broca" fore-sight 6 or 7 centimètres wide, and a tangent scale similar to that of the 90^{mm} gun, the spring might be dispensed with which now serves to give stability to the apparatus in the absence of a sufficiently broad base for it to rest upon. The apparatus for different guns would then only vary in the length of their rests. I was obliged to seek for a solution of the problem without touching the gun, for doubtless I should not have been permitted to make any alteration in the ordinary sights.

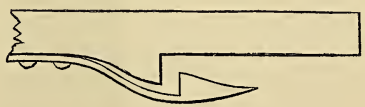
In the foregoing extracts, taken from notes kindly placed at my disposal by the author, I have endeavoured to give a sufficient idea of the principle and working of the telescopic apparatus, together with the various arguments which may be urged in favour of its adoption; but I have omitted many details which, however important in themselves, would have little interest for us owing to the difference which exists between the French *matériel* and ours.

E. WALSH,

Capt. R.A.

In the following sketches, which are not drawn to scale, Fig. 1 repre-

Fig. 1.



sents the front end of the rest with the spring underneath, which is passed through the orifice in the "Broca" fore-sight (Fig. 3), when the instrument is placed on the gun.

Fig. 2 shows rear and side elevation of the other end of the rest. The upper recess, in the form of a truncated V, holds the telescope, while the lower side is shaped in a similar manner so as to keep it steadily in position on the head of the tangent-scale.

Fig. 2.

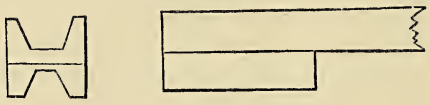


Fig. 3.

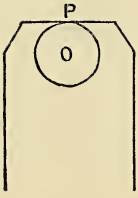


Fig. 4.

Fig. 4 shows the eye-piece of the tangent-scale.

Laying with the ordinary sights.

When the gun is correctly laid, the object is seen through the eye-hole *H*, in Fig. 4, at the point *P*, between the horns of the "Broca" fore-sight (Fig. 3).

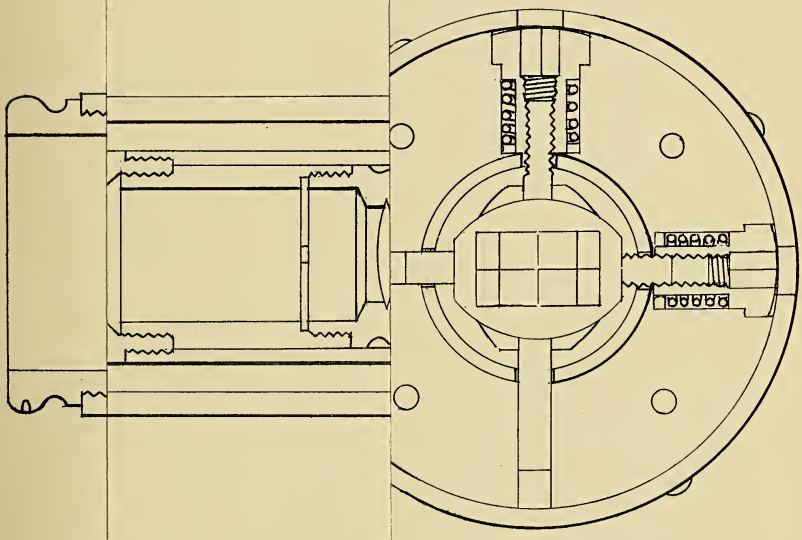
Laying with the telescope.

In laying with the telescopic apparatus, of course, it is only necessary to bring the cross-wires on the centre of the object.

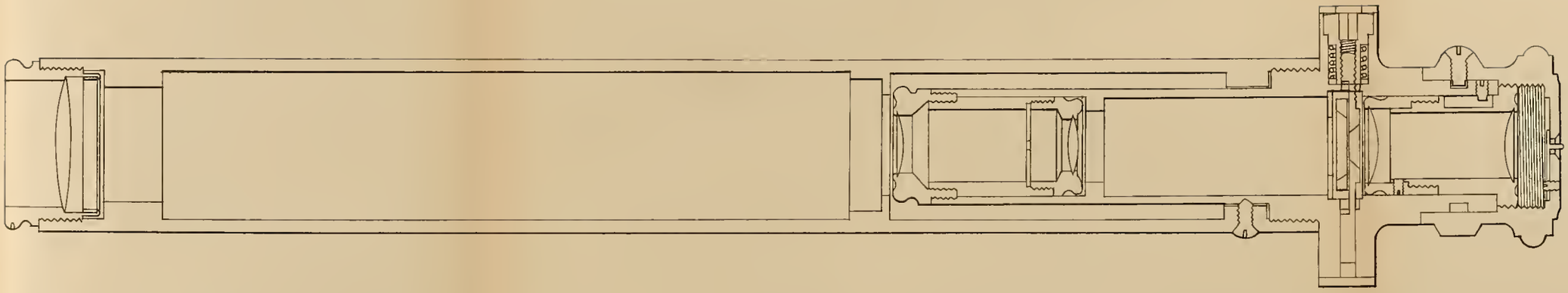
KINGSTOWN,
20th October, 1880.

E TELESCO*IONAL ELEVATION*

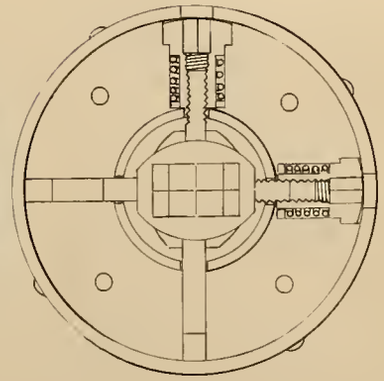
ROSS-WIRE DISK.



LONGITUDINAL SECTION OF THE TELESCOPE.



SECTIONAL ELEVATION OF CROSS-WIRE DISK.



DESCRIPTION OF A SPECIAL BOX

FOR THE

CARRIAGE OF THE AMMUNITION OF THE SECOND LINE OF ARTILLERY WAGONS DURING THE WAR IN AFGHANISTAN,

BY

CAPT. A. F. FLETCHER, R.A.

In consequence of the difficulty experienced in providing carriage for the supplies of the troops engaged in the late Afghan campaign—the loss of camels alone in that campaign is officially estimated at 61,000—and the rocky nature of the roads in the Khyber Pass, which were found to be ill adapted for draught bullocks, by which the 2nd line of wagons of batteries in India is usually drawn, General Sir Sam. Browne decided that these carriages belonging to the 1st Division Peshawar Field Force should be left behind, and that other arrangements should be made for the transport of their ammunition.

For this object a special box, to be carried on baggage animals, was proposed in the Peshawar Arsenal, and the pattern having been approved, Major-General Napier Campbell, R.A., Inspector-General of Ordnance, directed that a sufficient number should be made to supply all the batteries of the Peshawar Column with them, and that a pattern box should be sent to the Ferozepore Arsenal to guide the manufacture for issue to those of the Kurum Division. Some 300 boxes were accordingly made in the Peshawar Arsenal, and forwarded to the Commissary of Ordnance in charge of the Ordnance Field Park, P.F.F. They were packed and ready for issue, but it is believed that they never had an opportunity of being actually tried on service.

The design of the box is taken from the service 7-pr. M.G. ammunition box, but it is of wood instead of leather. The wood used is

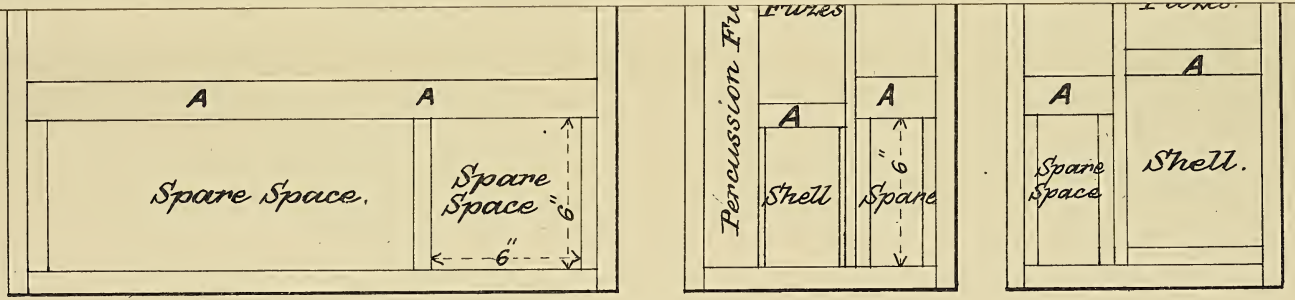
country deal, with fittings of sissoo. The maximum load for a camel in these operations being fixed at four *maunds* (320 lbs.), the number of rounds to be carried in each box was limited in accordance therewith.

The weight of the box empty is 54 lbs.
" " full is 153 lbs.

This limit permits nine rounds per box only, and consequently 72 boxes are required per battery, making 36 camel loads.

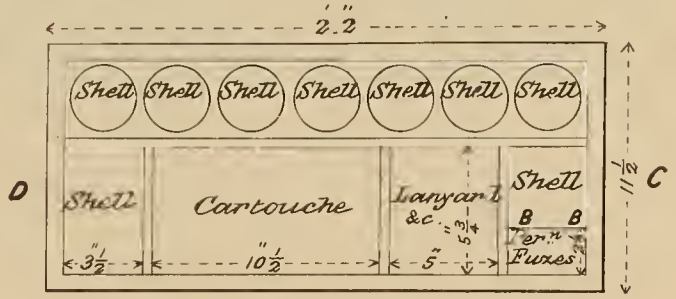
The sketch accompanying shows the internal arrangements and fittings, and also the measurements. The box is slung across the ordinary pack saddle of the camel by two chains with hooks. The chains are attached to iron bands passing round the box. The lid is secured with ordinary padlocks, and the box is fitted with rope handles for convenience of lifting.

Each box was packed with seven shrapnel and two common shell. The 72 boxes of a battery were divided into four portions of 18 each. The first 18 were marked "No. 1 boxes," the second 18 "No. 2," and so on. No. 1 boxes contained each ten 5-secs. fuzes; No. 2 boxes each ten 9-secs. fuzes; No. 3 boxes five 9-secs. and five 5-secs. fuzes, and also the friction tubes; No. 4 boxes ten 9-secs. and the percussion fuzes. The above details were arranged by the field park officers, but, as before stated, the boxes were never actually tried on service.

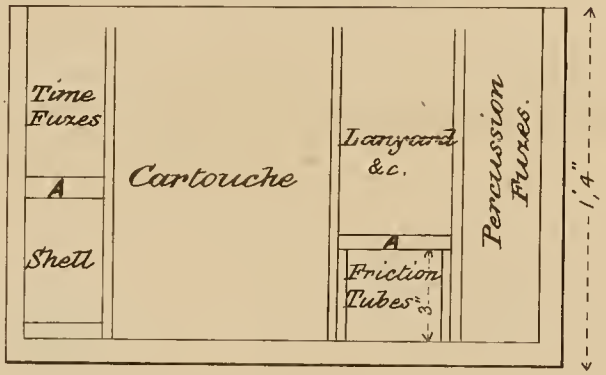


Pieces marked A. lift out by means of a small piece of leather.
The box is made of 1" plank-partitions of $\frac{1}{2}$" plank.
The partition marked B.B. in plan, is of $\frac{1}{8}$" sheet copper.

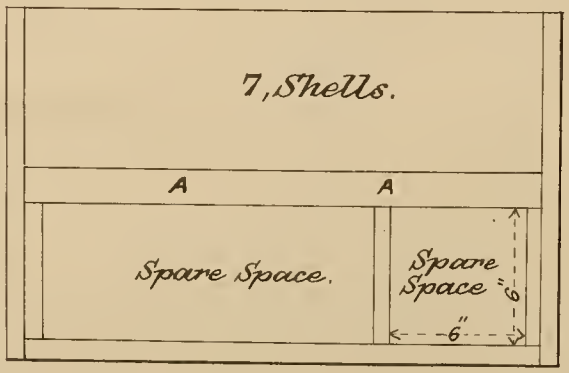
PLAN.



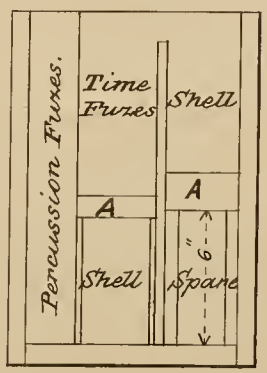
FRONT ELEVATION.



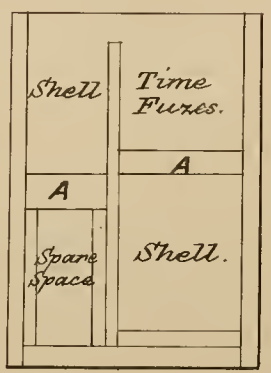
BACK ELEVATION



END. C.



END. D.



Pieces marked A. lift out by means of a small piece of leather.
The box is made of 1" plank-partitions of ½" plank.
The partition marked B.B. in plan, is of ⅛" sheet copper.

PRÉCIS OF CONTENTS

OF THE

"ORGAN DER MILITÄR-WISSENTSCHAFTLICHEN VEREINE."

PART 4, VOL. XXI.

BY

LIEUT. J. M. GRIERSON, R.A.

In this part we would draw attention to the "Repertoire of Military Journalism," published half-yearly by the "*Organ*." In it, arranged under such heads as "England," "Russia," "Field Artillery," "Tactics," "Military History," are mentioned all the articles bearing on those subjects which have appeared in the leading military papers in Europe and America. For purposes of study it is invaluable.

The first paper of importance is "A study of Constantinople, by Captain Ivanossich von Küstenfeld. After describing the advantages of situation, &c., of the town, and its historical development, the author proceeds to give an account of the defences of Constantinople during the war of 1877–8. Under this heading he includes the forts on the Dardanelles which form the first line of defence of the town against a naval attack from the west. Taking the actual armament of those forts and those on the Bosphorus into consideration, the writer declares his opinion that they could not be taken, nor even silenced by a naval attack. A landing on the north shore of the peninsula of Gallipoli he believes impossible, likewise an attack on the rear of the forts on the south bank of the Dardanelles; and then comes to the conclusion that "the only possible way of attacking those forts by land is by a line of operations based on the Balkans and branching in one direction against Constantinople, in the other against the Isthmus of Bulair." The latter is only five kilometres broad, and is defended by the lines of Bulair, built by the Allies in 1854, for a garrison of 20,000 men with 100 guns. For the immediate defence of the capital there are three lines of works, the Lines of Tchataldja, the Lines of Makriköi-Kilia (begun in 1878), and a last line immediately under the walls of the town from Baliskü to Bujukdere. For the adequate occupation and active defence of those lines, 100,000 men with 250 position and 120 field guns would be required. Thus held, and adequately provisioned and supplied, Constantinople would be in a nut which, in Captain von Küstenfeld's opinion, it would take the entire military and naval strength of any power in Europe to crack. The one weak point is the small and uncertain supply of water, which

can, besides, be cut off by the enemy. The article is well written and interesting, but the map accompanying it is totally insufficient for the comprehension of the text.

An article on the new German Military Law follows. The principle features of this law are:—(*a*) The peace strength of the army is raised from 401,659 men to 427,274 (1 per cent. of the population). (*b*) To provide *cadres* for this increase there are to be formed 11 infantry regiments (8 Prussian, 1 Bavarian, 2 Saxon), 1 infantry battalion (III./116), 1 field artillery regiment of 8 batteries (for the 15th Army Corps, which hitherto had but one), 32 field batteries (24 Prussian, 4 Bavarian, 2 Saxon, 2 Würtemberg), to be added to the divisions which have only 3 batteries of the corps artillery regiments. 1 Prussian foot artillery and 1 Prussian pioneer battalion, both for the 15th Army Corps. (*c*) The "Ersatz-Reserve," *i.e.*, the men who escaped service in the army, either by having drawn a high number, or for family or medical reasons, was formerly never called up in peace for training, and was only available in case of mobilization. By the new law, these men can be called up four times during their period of service in the Ersatz-Reserve, the first time for 10 weeks, the second for four, the others for two weeks each. (*d*) Formerly, men enrolled between the 2nd October and 31st March counted their service from the 1st October. In future they are only to count from the 1st April. Thus the whole army is now on the same footing, as men enrolled between the 1st April and 1st October count their service from the 1st April, and the first-named class of men are kept longer at the disposal of the field troops.

Thanks to the above measures, the German Empire has *cadres* for a war strength of:—

Field troops	771,749.
4th Battalions (Etappen, &c.)	161,000.
Landwehr	293,020.
Ersatz troops	341,480.
Garrison troops	125,834.
	1,693,083.

To fill up the ranks of those formations, it disposes of:—

12 contingents at 150,000 =	1,800,000.
Deduct 2 per cent. losses =	360,000.
	1,440,000.
Add 1st class Ersatz Reserve =	340,000.
Total	1,780,000.

Thus leaving 87,000 men over. Besides the above, the 2nd class Ersatz Reserve counts 150,000, the Landsturm 500,000 men. But now comes the weak point in the system. Allowing only 1 officer for 80 men (a very small proportion), the above force would require 40,000 officers. At present Germany possesses 17,000 line, 6,200 reserve, and 6,800 landwehr officers, total 30,000—or 10,000 short of

the required number! This, we believe, will have a most serious effect on the efficiency of the German army in a future war. The value of a corps of officers is not ascertained by considering the state of training of its best members, but by taking an average; and the German reserve and landwehr officers are confessedly very little acquainted with their duties, and are inferior to our militia, and to many volunteer officers.

The most interesting paper in the number, from an artillery point of view, is "The handling of horse artillery," which, although written by an infantry officer, Major Weissmann of the 67th Regiment, is well worthy of most careful study. He divides his essay into three heads:—(1) How, in future, should horse artillery *not* be used; (2) Is it necessary to add horse batteries to cavalry divisions, and if so, when and how should they be used; (3) What conditions must the organization and gun, &c., construction fulfil. To the first question the answer is, horse batteries should no more be used to accompany cavalry attacks, in which, under the most favourable circumstances, they have only time to fire one or two rounds. On this subject, and on the uselessness of the practice of pushing horse batteries at a hard gallop to the front to a favourable position for preparing the attack of cavalry, the authors remarks are most convincing. On considering the second head, Major Weissman concludes that horse batteries should form an integral part of the cavalry division, but that it by no means follows that the action of the two arms should *of necessity* be simultaneous. With cavalry corps covering the advance or retreat of an army, guns become a necessity for the storming of detached posts, villages, &c., or for defending temporary positions which cavalry alone, with its small defensive power, could not hold. On the battle-field, contrary to most received notions, the author expresses his opinion that all artillery are alike, and that horse batteries lose their importance and are even inferior in usefulness to the heavier batteries. He deplores the absence of horse batteries in the corps artillery of the Austrian army (a complaint which we have no cause to echo), as this force cannot be pushed to the front as quickly as might be desired. The battle of Mars-la-Tour (a well-chosen example) is then described with special reference to the horse artillery, which appears to have acted in general as above described. In the answer to the third question little new matter is brought to light; in fact the author desires to reduce the number of the mounted detachment and carry five men on the gun. On the whole the paper is very well written, and the arguments are carefully worked out and lucidly expressed. As expressing Austrian views on the subject it is an interesting contribution to field artillery literature.

The remaining papers are:—"The tactics of supporting points," a sequel to a former paper on the subject; an article on "Steppe warfare," most of the matter of which is contained in the Intelligence Department pamphlet on "Steppe campaigns"; and a continuation of the collection of Turkish documents relating to the Russo-Turkish war.

Extracts from the "Revue d'Artillerie," November, 1880.

BY

CAPTAIN A. E. TURNER, R.H.A.

GERMANY.—ISSUE OF A REPEATING CARBINE TO THE RIFLE BATTALION OF THE GUARD. (DAS GARDE SCHÜTZEN BATAILLON).

On the 23rd and 24th October last, a weapon of this description, being the Mauser rifle converted into a repeater on the Löwe system, was issued to the men of the above battalion, one company of which mounted guard on the Castle (Berlin) armed with it, on the first day. Some weeks previous, one of these carbines per company had been supplied to this battalion for experimental purposes, being in each case, placed in the hands of one of the musketry instructors (non-commissioned officers) who had been trained to its use at the School of Musketry at Spandau.

The magazine consists of a box made of steel, and weighs 12 ozs.; it contains eleven cartridges, such as are used with the Mauser rifle; it can be carried either attached to the arm or not, and the latter can at any time be used as a single rifle. Experiments have shown, that men, trained to use it, can fire twelve rounds of aimed fire in 35 secs., but that in the hands of untrained men, no rapidity is gained over the single Mauser rifle.

The troops, to whom it has been issued, are by no means partial to the new weapon; they complain of the difficulty of extracting the expended cartridge cases, and of the increased weight of their fire-arm caused by the addition of the magazine and its contents.

GERMANY.—KŒNIGSBERG AND KŒNIGSTEIN.

The fortifications at both the above places are being strengthened. At the former three new detached forts are in process of construction

on the north-west front; and the whole of the new works are in a sufficiently far advanced state to enable them to be armed forthwith.

The fortress of Kœnigstein is to be entirely re-modelled and greatly enlarged, its works being of a nature quite obsolete: a sum of £750 has been voted for this service for the year 1880.

ITALY.

The six batteries of mountain artillery are at once to be formed into one regiment, being removed from the regiments of garrison artillery, of which they hitherto have formed part. The new regiment is to be stationed at Turin, and is to be under the command of a field officer (*officier supérieur*); the batteries are intended to support the "Alpine companies," and are always to be kept in readiness for service. Their officers are to be selected with great care, and entirely from among those who have been educated in the military college. No officers from the ranks will be allowed to serve in this regiment, which is intended to be a special *corps d'elite*.

ALDERSHOT,
11th December, 1880.

CONTENTS OF THE

Mittheilungen über Gegenstände des Artillerie-und-Genie-Wesens.

(10th and 11th Parts, 1880.)

BY

CAPT. G. C. WYNNE, R.A.

These numbers contain the following essays, notices, &c. :—

1. Experiments at Shoeburyness, 1879-1880, with 6-in. and 8-in. Armstrong breech-loading guns. From the original report by Captain Noble.

2. The present position of the Question of Fortifications in Italy.

3. Experiments with the Second 38-ton Gun of the Thunderer.

This article concludes with the following significant paragraph :— "Although it is undoubtedly clear from the above that the bursting of the Thunderer gun was due to double loading and not to any defect in its construction, or in the material of which it was made, yet it can not be denied that such an accident would be impossible in a breech-loading gun."

4. The Construction of the Railway Bridge over the Save at Brood (1878-1879).

Shorter Articles.

1. The Spanish Light Field Guns.

2. The Spanish Time Fuze (M. 1880).

This seems to bear a strong resemblance to the "E" time fuze.

3. Light Spades for the Spanish Infantry.

The sheath of the bayonet, which is of wood, forms the handle of the

spade, the bayonet itself joining the handle and the blade. The bayonet slides into a groove in the latter, that part which fastens to the rifle being fitted into the handle and secured by a hook.

4. The Construction of Military Carriages.

This is from the Russian, and would possess no interest for the readers of the "Proceedings."

5. The Organisation of the Swiss Engineers.

6. The Production of Sparks by Flint and Steel.

Some short notices of articles in other journals, and of two books, conclude these numbers.

NOTE

ON

ELEMENTARY SQUAD DRILL

IN THE SWISS ARMY,

BY

CAPTAIN C. S. GRAHAM, R.A.

---

1. The turnings are thus taught in Switzerland. Instead of all the complications involved in drawing back or advancing the right or left foot, as the case may be, to turn to the right or right-about; the right toe and left heel are raised so that the right heel becomes the pivot and the left toe the point where the power is applied to turn the body. When the turning is completed the left heel is brought to the right, the usual position of attention being assumed. Turning to the left the left toe and right heel is raised, &c.

2. The formation of fours is accomplished by oblique movements on the part of the even Nos. or left files, instead of square movements after the manner of a knight's move on a chess board. In fact a man gets into his new place in a way which, being the shortest, comes most natural to him. Time is thus saved, an important matter in the present day. As every man is allowed a lateral space of 24 ins., it will be found in practice that although the left files move obliquely they are not in the least likely to jostle the right files; a danger which such elaborate precautions are taken against in our drill book.

TRAJECTORIES OF THE 9-PR., 13-PR., AND 16-PR. M.L.R. GUNS.

BY

LIEUT. P. A. MACMAHON, R.A.

In the calculation of these trajectories the approximation given by Major Sladen, R.A., at p. 67, of "Principles of Gunnery," has been employed.

The angles of elevation being low, the resistance of the air has been considered to act only horizontally, so that its effect upon the vertical component of the velocity has been neglected. This amounts to the substitution of $\frac{dx}{dt}$ for $\frac{ds}{dt}$ in the expression $-2b\left(\frac{ds}{dt}\right)^3$ for the atmospheric resistance.

This method is satisfactory for flat paths, but as the elevation is increased, it tends to make the path less curved at the commencement than it should be, and if carried beyond certain limits, it would actually cause a convexity of the path at the beginning. The remaining velocities at every hundred yards from the muzzle were first obtained from the formula—

$$S_v = S_V - \frac{d^2}{w}\, s\,.$$

The differences of these velocities were found to be irregular, about the region where they were very nearly equal to the velocity of sound. This might be expected, as the air just in front of the projectile becomes disturbed by the propagation of the whirring sound of the shell—as the velocity of the shell falls below that of sound. These velocities were tabulated, and the times from the muzzle to each distance, thence calculated from the time-integral formula

$$t = \frac{w}{d^2}\left(T_V - T_v\right).$$

In order to ensure the successive first and second differences of these times being fairly regular, it was necessary in the first place to obtain the velocities to decimals of a foot, and to employ proportional parts in taking out the times from the time-integral table. The heights of the trajectories at a hundred yards from the muzzle for each range were then deduced by successive application of the formula

$$y = \frac{1}{2} gt\,(T - t)\,;$$

where t = time from muzzle to a hundred yds. distance,

T = whole time of flight for the particular range.

This was then repeated for all the other distances from the muzzle.

In these tables, the vertical column on the left shows the ranges fired at, and the horizontal column at the top distances in yds. from the muzzle.

Their intersections give the heights of the paths above the muzzle in feet.

With regard to the angle of descent I find that it can be expressed as a function of the range of the form

$$An^2 + Bn + C,$$

where n is the range in hundreds, and decimals of a hundred yards, and A, B, and C are constants readily determined for any particular gun.

Take, for instance, the 13-pr. M.L.R. gun. In this case

$$A = \cdot 38,\ B = 6 \cdot 25,\ C = 1 \cdot 5,$$

and the formula becomes—

$$\text{angle of descent in minutes} = \cdot 38n^2 + 6 \cdot 25n + 1 \cdot 5.$$

Suppose we require the angle for 3360 yds. range; we get

$$\cdot 38 \times (33 \cdot 6)^2 + 6 \cdot 25 \times 33 \cdot 6 + 1 \cdot 5$$

$$= 428 \cdot 9 + 210 + 1 \cdot 5,$$

$$= 640 \cdot 4 \text{ minutes.}$$

Therefore, the required angle is 10° 40′.

For the 16-pr. gun the formula is—

$$\text{angle of descent in minutes} = \cdot 38n^2 + 10 \cdot 45n - 4 \cdot 5,$$

and

$$\cdot 44n^2 - 10 \cdot 34n - 6$$

for the 9-pr.

These formulæ are very accurate, and may be relied upon for results, differing very slightly from those obtained from the most exact methods. They have certainly the great advantage of being independent of tables, and of all knowledge of velocities and times for their calculation.

A reliable statement of the trajectory of the shell for the last two or three hundred yards of the ranges is undoubtedly of much assistance to the officer recording results in the range report during practice. By means of pegs and flags there is no difficulty in telling how far short or over a shrapnel shell bursts, but the height above plane is so very deceptive that the conjectures of practised observers often widely differ. It will, therefore, I think be of use in such a case to know at what height above the plane a shell should burst at a given distance from the target, supposing the gun to be correctly laid.

For an instance, suppose the practice is with the 13-pr. at 2500 yds. range, and that the shell is judged to burst 90 yds. short; from the table we see that at a hundred yds. from the target, the height of the shell is 33 ft., and moving the decimal point one place to the left we obtain 3·3 ft. for the vertical height due to 10 yds. distance from the target; thus 9 × 3·3 ft. or 29·7 ft. is the height of the burst, presuming that the gun is well laid. A moment's reference to the table thus forms a good guide to the judgment, and if the laying be not reckless, a very wrong guess could not be given.

The height of the bull's eye of the target must of course be added to the numbers in the tables.

We can also find how far in front of the point of impact a man would be struck; taking his height at 5·5 ft. we have—

$$3{\cdot}3 : 10 :: 5{\cdot}5 : x \text{ (required distance in yards)},$$

$$\therefore x = \frac{550}{33} = 16\tfrac{2}{3} \text{ yds.}$$

A shell striking twenty or twenty-five yds. over at this range would thus pass over the heads of a line of men.

Approximate Rule for Finding the Highest Point of the Trajectory.

If h be the height in feet, and t the time of flight in secs., then,

$$h = t^2 \times 4.$$

9-pr. R.M.L. Gun.—M.V. = 1390 f.s. $\frac{d^2}{w} = \cdot 8884$.

Distance from muzzle of gun in yds., and corresponding height of trajectory in ft.

Range in yds.	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	Angl. of descent.	Range in yds.
																																° ′	
500...	0	3	5	5	4	0																										0 57	500
600...	0	4	7	8	8	5	0																									1 11	600
700...	0	5	9	11	12	10	6	0																								1 28	700
800...	0	6	11	15	16	16	13	8	0																							1 45	800
900...	0	7	13	18	20	21	20	16	9	0																						2 3	900
1000...	0	8	15	21	25	27	27	24	19	11	0																					2 22	1000
1100...	0	9	18	24	29	33	34	32	29	22	13	0																				2 42	1100
1200...	0	10	20	28	34	38	41	41	38	33	25	14	0																			3 2	1200
1300...	0	12	22	31	39	44	48	50	49	45	38	29	16	0																		3 23	1300
1400...	0	13	25	35	43	50	56	58	59	57	52	44	33	18	0																	3 46	1400
1500...	0	14	27	38	48	57	63	67	69	69	65	59	49	36	20	0																4 9	1500
1600...	0	15	29	42	53	63	70	76	79	80	79	73	65	54	39	21	0															4 32	1600
1700...	0	16	32	46	58	70	78	85	90	93	92	89	83	73	60	43	25	0														4 57	1700
1800...	0	17	34	49	63	77	86	95	102	106	107	105	101	93	82	67	49	27	0													5 23	1800
1900...	0	19	37	53	68	83	94	105	113	118	121	121	118	112	103	90	74	54	28	0												5 50	1900
2000...	0	20	39	57	73	89	102	114	123	130	135	137	135	131	123	112	97	79	56	29	0											6 17	2000
2100...	0	21	42	61	79	97	111	124	130	144	150	154	154	152	146	137	124	108	87	62	35	0										6 45	2100
2200...	0	22	44	63	84	104	119	134	145	157	165	171	173	172	168	161	150	136	116	94	69	36	0									7 15	2200
2300...	0	24	47	69	90	110	127	144	158	170	180	187	191	192	189	184	175	162	145	124	101	70	36	0								7 43	2300
2400...	0	25	50	73	95	117	136	154	171	185	196	205	211	214	213	210	203	192	177	159	138	109	78	43	0							8 16	2400
2500...	0	26	52	77	101	124	145	165	183	199	212	222	230	235	236	235	230	221	208	192	173	147	117	85	44	0						8 48	2500
2600...	0	27	54	81	106	130	153	175	194	211	226	239	248	255	258	258	255	249	238	224	206	182	155	124	85	44	0					9 19	2600
2700...	0	29	58	86	112	138	162	186	207	227	243	258	269	278	283	286	285	280	271	259	244	222	197	169	133	94	52	0				9 55	2700
2800...	0	30	60	90	118	146	171	196	220	240	259	275	289	299	307	311	312	310	303	293	280	260	238	212	178	141	102	52	0			10 30	2800
2900...	0	32	64	94	124	154	181	208	233	255	276	294	309	322	332	338	340	340	336	329	317	300	280	256	225	190	154	106	57	0		11 6	2900
3000...	0	33	66	99	130	161	190	219	246	271	293	313	330	345	357	365	370	373	371	365	356	342	324	302	274	242	207	162	115	61	0	11 44	3000
Vels.		1337	1288	1241	1198	1159	1122	1087	1056	1036	1008	988	970	953	937	922	908	894	880	867	855	842	830	819	807	796	786	775	765	755	745		
Times secs	0	·22	·45	·69	·93	1·19	1·45	1·72	2·01	2·29	2·59	2·89	3·20	3·51	3·83	4·15	4·47	4·80	5·15	5·49	5·82	6·20	6·56	6·90	7·29	7·67	8·02	8·43	8·81	9·21	9·52		
Yds. from muzzle	.....	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000		

16-pr. M.L.R. Gun.

The intersections of the Horizontal and Vertical Columns give the Heights of the Trajectory above the Muzzle in feet.

Yards from Muzzle.

Range in yds.	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	Angl. of descent.	Range.
																																° ′	
500...	0	3·5	5·5	5·6	3·8	0																										0 56	500
600...	0	4·5	7·4	8·5	7·8	4·9	0																									1 11	600
700...	0	5·5	9·4	11·5	11·9	10·2	6·2	0																								1 26	700
800...	0	6·4	11·4	14·6	16·1	15·5	12·9	7·7	0																							1 43	800
900...	0	7·5	13·5	17·8	20·4	21·0	19·6	15·7	9·2	0																						1 60	900
1000...	0	8·5	15·6	21·0	24·7	26·4	26·1	23·5	18·3	10·4	0																					2 18	1000
1100...	0	9·9	17·8	24·3	29·3	32·2	33·1	31·8	27·9	21·3	12·3	0																				2 36	1100
1200...	0	10·7	20·0	27·7	33·9	38·0	40·1	40·1	37·6	32·5	24·8	13·9	0																			2 56	1200
1300...	0	11·7	22·2	30·9	38·3	43·6	46·9	48·2	47·0	43·2	36·8	27·3	14·8	0																		3 15	1300
1400...	0	12·9	24·5	34·5	43·1	49·7	54·3	57·0	57·2	54·9	50·0	42·0	30·9	17·7	0																	3 36	1400
1500...	0	14·1	26·9	38·1	47·9	55·8	61·7	65·8	67·5	66·6	63·1	56·7	47·2	35·4	19·3	0																3 57	1500
1600...	0	15·2	29·2	41·5	52·7	61·8	69·0	74·5	77·5	78·1	76·1	71·1	63·2	52·8	38·3	20·8	0															4 20	1600
1700...	0	16·3	31·5	45·0	57·3	67·7	76·2	82·9	87·4	89·3	88·7	85·2	78·7	69·8	56·9	40·7	22·7	0														4 41	1700
1800...	0	17·6	34·0	48·9	62·6	74·4	84·3	92·5	98·6	102	103	101	96·5	89·2	78·0	63·7	46·3	24·7	0													5 5	1800
1900...	0	18·7	36·3	52·3	67·4	80·3	91·5	101	109	114	116	116	112	107	97·0	84·2	68·4	50·0	26·8	0												5 29	1900
2000...	0	20·0	38·8	56·3	72·7	87·2	99·7	111	120	127	131	132	130	126	118	107	93·3	76·6	53·9	29·0	0												5 54	2000
2100...	0	21·2	41·4	60·0	77·8	93·5	108	120	131	139	144	147	147	145	139	129	117	102	81·3	59·4	31·3	0										6 19	2100
2200...	0	22·5	44·0	63·9	83·1	100	116	130	142	152	159	164	165	164	160	152	142	129	110	89·6	63·1	33·4	0									6 45	2200
2300...	0	23·6	46·4	67·6	88·1	107	123	139	153	164	172	179	182	182	180	174	165	154	137	118	93·3	66·0	35·8	0								7 12	2300
2400...	0	25·0	49·2	71·8	93·8	114	132	149	165	178	188	196	201	203	203	199	192	182	167	150	128	103	72·6	38·3	0							7 40	2400
2500...	0	26·3	51·8	75·7	99·2	121	140	159	176	191	203	212	219	223	224	222	217	209	196	181	160	137	109	76·7	40·4	0						8 8	2500
2600...	0	27·5	54·2	79·4	104	127	148	168	187	203	216	227	236	241	244	244	240	233	222	209	191	169	143	114	81·5	43·2	0					8 38	2600
2700...	0	28·9	57·1	83·7	110	134	157	179	199	217	232	245	255	263	267	269	267	263	254	242	226	206	182	156	123	85·3	45·9	0				9 8	2700
2800...	0	30·2	59·6	87·6	115	141	165	189	210	230	246	261	273	282	289	292	292	289	282	273	260	242	220	194	164	131	92·1	48·4	0			9 39	2800
2900...	0	31·6	62·6	92·2	122	149	175	200	223	245	263	280	294	305	313	319	321	320	315	308	298	283	264	240	211	177	138	96	51·4	0		10 10	2900
3000...	0	33·0	65·4	96·4	127	156	183	210	236	259	279	298	313	326	337	344	348	349	346	341	331	317	299	279	254	224	189	149	104	54·6	0	10 42	3000
Vels.	1355	1313	1274	1236	1200	1167	1135	1106	1078	1054	1032	1013	996	981	966	952	939	927	914	903	891	880	869	859	849	838	829	819	810	800	791		
Times secs	0	·22	·45	·69	·94	1·19	1·45	1·72	2·00	2·28	2·57	2·86	3·17	3·46	3·77	4·09	4·41	4·71	5·06	5·37	5·72	6·06	6·41	6·73	7·11	7·46	7·79	8·17	8·52	8·93	9·31		
Yds.from muzzle	.....	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000		

Weight of projectile taken to be 17·5 lbs., being the average of those taken into the field.

13-pr. M.L.R. Gun.

The intersections of the Horizontal and Vertical Columns give the Heights of the Trajectory above the Muzzle in feet.

Yards from muzzle.

Range in yds.	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	Angl. of descent.	Range.
																																					° ′	
500...	0	2·5	3·9	4·0	2·8	0																															0 41	500
600...	0	3·2	5·3	6·1	5·6	3·6	0																														0 51	600
700...	0	3·9	6·7	8·3	8·5	7·3	4·5	0																													1 2	700
800...	0	4·6	8·1	10·5	11·5	11·1	9·1	5·5	0																												1 14	800
900...	0	5·3	9·6	12·8	14·6	15·0	13·9	11·1	6·6	0																											1 27	900
1000...	0	6·1	11·2	15·1	17·8	19·1	18·8	16·9	13·3	7·7	0																										1 41	1000
1100...	0	6·9	12·8	17·5	21·0	23·2	23·9	22·9	20·3	15·7	9·0	0																									1 55	1100
1200...	0	7·7	14·4	20·0	24·4	27·5	29·0	29·1	27·4	23·7	18·1	10·2	0																								2 11	1200
1300...	0	8·5	16·1	22·5	27·8	31·8	34·3	35·3	34·6	32·1	27·5	20·6	11·6	0																							2 27	1300
1400...	0	9·3	17·7	25·1	31·3	36·2	39·7	41·7	41·9	40·4	36·9	31·2	23·3	12·9	0																						2 45	1400
1500...	0	10·2	19·4	27·7	34·8	40·6	45·1	48·1	49·4	48·9	46·5	41·9	35·1	25·8	14·2	0																					3 2	1500
1600...	0	11·1	21·2	30·4	38·5	45·4	50·9	54·9	57·3	58·2	56·7	53·3	47·7	39·7	29·3	16·4	0																				3 21	1600
1700...	0	12·0	23·1	33·2	42·2	50·1	56·6	61·7	65·2	67·0	66·9	64·7	60·4	53·6	44·4	32·8	17·8	0																			3 40	1700
1800...	0	12·9	24·9	35·9	46·0	54·9	62·4	68·6	73·2	76·2	77·2	76·2	73·1	67·6	59·7	49·4	35·7	19·3	0																		3 59	1800
1900...	0	13·8	26·8	38·7	49·8	59·8	68·4	75·7	81·4	85·5	87·7	87·9	86·1	84·9	75·3	66·3	54·0	39·0	21·1	0																	4 19	1900
2000...	0	14·7	28·6	41·6	53·8	64·7	74·4	82·8	89·7	94·9	98·5	99·9	99·3	96·4	91·1	83·5	72·6	59·1	42·6	22·9	0																4 40	2000
2100...	0	15·7	30·5	44·6	57·7	69·7	80·5	90·0	98·1	105	109	112	113	111	107	101	91·4	79·3	64·2	46·1	24·6	0															5 2	2100
2200...	0	16·6	32·5	47·5	61·8	74·9	86·8	97·4	107	114	120	124	126	126	124	119	111	99·9	86·4	69·8	49·9	26·8	0														5 24	2200
2300...	0	17·6	34·5	50·6	65·8	80·1	93·1	105	115	124	132	137	140	141	140	137	130	121	109	93·9	75·6	54·2	28·9	0													5 48	2300
2400...	0	18·6	36·5	53·7	70·0	85·4	99·6	113	124	135	143	150	154	157	157	155	150	143	132	118	102	81·8	58·3	31·0	0												6 12	2400
2500...	0	19·6	38·6	56·8	74·2	90·8	106	120	133	145	155	163	169	173	174	174	170	164	155	143	128	110	87·9	62·4	33·1	0											6 37	2500
2600...	0	20·6	40·6	59·9	78·5	96·2	113	128	142	155	166	176	183	189	192	192	191	186	179	168	155	138	118	94·1	66·6	35·3	0										7 2	2600
2700...	0	21·7	42·7	63·1	82·8	102	119	136	152	166	178	189	198	205	209	211	210	208	202	194	182	167	148	126	100	70·8	37·4	0									7 28	2700
2800...	0	22·7	44·8	66·3	87·2	107	126	144	161	176	190	202	212	221	227	230	232	231	226	219	209	196	179	159	135	107	75·2	39·7	0								7 55	2800
2900...	0	23·8	47·0	69·6	91·6	113	133	152	170	187	202	216	227	237	245	250	253	253	251	245	237	225	210	192	169	143	114	79·9	42·1	0							8 23	2900
3000...	0	24·8	49·1	72·9	96·1	119	140	160	180	198	214	229	242	254	263	270	274	276	275	271	265	255	242	225	204	180	152	121	84·6	44·4	0						8 51	3000
3100...	0	25·9	51·4	76·3	101	124	147	169	189	209	227	243	258	271	281	290	296	299	300	298	293	285	273	258	239	217	191	161	127	88·5	46·0	0					9 20	3100
3200...	0	27·0	53·5	79·6	105	130	154	177	199	220	239	257	273	288	300	310	318	323	325	325	322	315	306	292	276	255	231	203	171	135	94·5	50·5	0				9 50	3200
3300...	0	28·1	55·7	83·1	110	136	161	186	209	231	252	271	289	305	318	330	339	346	351	352	350	346	338	327	312	294	271	245	215	181	143	101	52·1	0			10 21	3300
3400...	0	29·2	57·2	86·6	115	142	168	194	219	242	265	286	305	322	338	351	362	371	376	380	380	377	371	362	349	332	312	288	260	228	191	151	105	55·1	0		10 53	3400
3500...	0	30·4	59·4	90·1	119	148	176	203	229	254	278	300	321	340	357	372	385	395	403	408	410	409	405	397	386	372	354	331	305	275	241	203	159	111	58·3	0	11 25	3500
Vels.	1595	1550	1505	1462	1419	1378	1339	1302	1266	1232	1199	1169	1140	1112	1086	1063	1044	1027	1011	996	984	967	953	940	927	914	902	890	878	867	856	845	834	824	814	804		
Time sec.	0	·19	·38	·58	·79	1·01	1·23	1·46	1·69	1·93	2·18	2·43	2·69	2·96	3·23	3·50	3·79	4·08	4·38	4·68	4·98	5·29	5·60	5·92	6·25	6·58	6·91	7·25	7·59	7·93	8·28	8·63	8·99	9·35	9·72	10·1		
Yds. from muzzle.	...	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500		

Woolwich,
November, 1880.

REVUE MILITAIRE DE L'ETRANGER,
(1st Jan., 16th Jan., 1st Feb., 1881.)
TRANSLATED BY

LIEUT. R. M. BOND, R.A.

INFANTRY FIRE IN FORTRESS WARFARE,

BY

LIEUT.-COL. BOGUSLAWSKI.

Lieut.-Col. Boguslawski has just published an appendix, "Die Hauptwaffe in Form und Wesen," to his well-known work, "Die Entwicklung der Tactik."

His ideas on the subject of long range fire are still the same; he still remains the champion of a vigorous offensive and bold advance, and of rapid fire at short ranges preceding the assault with the bayonet.

According to the Colonel, infantry will no longer be reduced, as in former fortress warfare, to direct its fire exclusively against the sapheads of the besieger, or the embrasures of the ramparts in order to harass and decimate those serving the guns. Its *rôle* will be of a more extended nature. It will be able by combining its fire with that of the siege artillery to assist in sweeping the ramparts, and to render them, at times, untenable by the garrison. This employment of infantry fire seems destined to give important results against detached forts, and more especially so against isolated works. It will nearly always be possible to surround such works on two or three sides by large detachments of infantry, who will rapidly obtain cover. If this infantry can be placed in such a manner as to be able to enfilade the prolongation of the faces, the effects of its fire will in great measure surpass those of the ricochet fire of Vauban, and will with far greater certainty oblige the garrison to get under cover.

The defence of the rampart by infantry is exceedingly weak, at least in the new German forts, for the numerous hollow traverses which we find there absorb the greater part of the available space. The fusillade can only be effectively answered from the covered way, or from the shelter trenches situated in front, unless a low rampart is placed in front of the principal one, which give infantry the necessary space for deployment.

A body of troops intrenched in the prolongation of a face will be able to deluge it in its entire length with bullets if they fire at two or three elevations, according to the length of that face. Four companies of 250 men distributed around a fort will be able to discharge into it 200,000 bullets in the space of two hours. At 700 mètres the angle of descent of the trajectory of the Mauser rifle is 2° 30′, at 1000 mètres 5° 4′ 4″; between 1200 and 1500 mètres it varies from 7° to 10°, and at that distance the bullet still retains a considerable power of penetration. Consequently, besides enfilade fire, it will be possible to direct straight on the parapets of the fort a plunging fire causing enough

annoyance to stop the movements of the garrison on the rampart, and taking in reverse the defenders of the opposite face, even over the traverses of the capital, when such exist.

At the *début* of the attack of large places with entrenched camps, the *rôle* of infantry will be still more considerable. The detached forts which surround them must be joined, in time of need, by lines of field fortification and batteries of position. The besieger, by appearing rapidly before the place, and by seconding the fire of his first siege batteries by a violent infantry fire, will be so able to command the ground between two or three forts, that it will be impossible for the besieged to establish or to strengthen his intermediate lines. Under these conditions, the besieger will perhaps be able to penetrate by main force across the line of exterior defences, and completely surround one of the forts. It is in this attack of intermediate lines that the employment of combined artillery and infantry fire at long ranges seems to be an innovation both fortunate and practical. It is, so to speak, on a larger scale, the reproduction of the ordinary conditions of war in the field, a violent fire disorganizing the defence and preceding the assault.

It is true that this long range fire will not have the efficacy of rapid fire at a short distance on the field of battle; but it is a sufficient compensation that the besieger is disposing of far superior forces. Under these circumstances, the passive obstacle presented by field works being very small, the lines which the long range fire will have caused to be more or less evacuated may very possibly fall before a rapidly conducted attack.

In front of the forts themselves the results to be hoped for do not appear quite so distinct. The long-range infantry fire will certainly harass the defenders; but this fire will not be able sufficiently to prepare an attack which, even supposing the parapets are completely evacuated, would probably break down before the obstacles left uninjured by the artillery, and would only bring the attacking party under the flanking fire of the ditches.

Lieut.-Col. Boguslawski dwells upon the necessity of instructing both officers and rank and file in this new employment of fire, and proposes to create a special fortress infantry, just as there is a fortress artillery. In fact, he believes that the part assigned to infantry at the commencement of a siege will undergo considerable transformation and extension in the future. Up to the present time it had not gone beyond investing and protecting the establishment of the first batteries; henceforth, from passive it will become active, thanks to the highly improved armament which it possesses.

ACTUAL STATE OF FIELD ARTILLERY IN ENGLAND.

The final conclusion of the *Revue* on our field artillery is, that England is far behind the other powers of Europe in point of *matériel*, and that whilst of late years other nations have been making real progress in their gun manufacture, England alone has remained stationary.

GERMAN IMPERIAL MANŒUVRES, 1880,

BY

CAPTAIN A. E. TURNER, R.H.A.

The importance with which the annual exercise of troops in mimic warfare is regarded by the German government, may be gathered from the fact that, from the middle of August to the middle of September, every portion of its huge army is on the move; and commencing with the exercises of each arm separately, these are gradually combined and duly trained in their mutual action in relation to one another; then brigades are pitted against brigades, divisions against divisions, or against skeleton enemies (*markirte feind*); and lastly, where the manœuvres are on a large scale, as those held in the vicinity of Berlin, one army corps contends against another, according to a general idea, which is said to emanate from Graf Moltke himself.

Such were the Imperial manœuvres of 1880, in which the Garde and 3rd (or Brandenburger) Army Corps were brought into play. Both these corps are especially renowned: the former under the Crown Prince of Germany turned the tide at the battle of Königgratz, by its magnificent attack on the Austrian right; while in the war of 1870, after suffering the most unparalleled losses during its first advance against the heights of St. Privat le Montaigne, it pressed forward a second time supported by the Saxons, hurled the French back from their strong positions and decided the fate of the battle of Gravelotte and of Bazaine's army. The Brandenburgers were the first to come into contact with the French, near Vionville, on the 16th August, 1870; the latter were for a long time vastly superior in numbers, but the 3rd Army Corps, though with terrible losses, held on with desperate tenacity to positions which it had taken up across the line of Bazaine's retreat on Verdun, and, being at length reinforced by the 8th, 9th, and 10th Corps, succeeded in frustrating his movement.

Seven actual days were taken up by the reviews and manœuvres executed in the presence of the Emperor; the programme was as follows:—

10th Sept. Review of the 3rd Army Corps by the Emperor.

11th Sept. Exercise of 3rd Army Corps against a skeleton enemy.

13th Sept. Review of the Garde Corps by the Emperor.

14th Sept. Exercise of the Garde Corps against a skeleton enemy.

16th, 17th, 18th Sept. Manœuvres (*à double action*) of the Garde Corps against the 3rd Army Corps.

The strength of the corps was as follows:—

Garde Corps—

Officers	944.	
Under officers	2447.	(*unter offiziers.*)
Bandsmen	1392.	
Privates	22,615.	
Total ...	27,398,	

together with 5701 horses and 72 guns.

N.B.—The battery of instruction (4 guns), the cadet school, the *unter offiziers* school, &c., were attached to the Garde Corps, and included in these numbers.

3rd Army Corps—

Officers	654.
Under officers	1540.
Bandsmen	1079.
Privates	14,783.
Total ...	18,056,

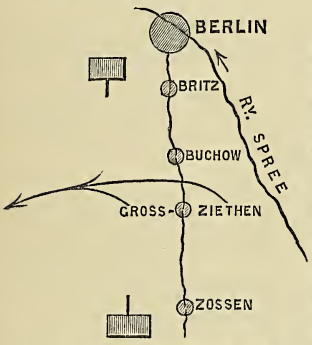
with 4290 horses and 68 guns.

The reviews were held on the large plains of Templehof, close to Berlin on the south, where all the troops stationed in the capital exercise, and where, in the early part of the year, all arms may be seen threading their way, and apparently mingled up; no ground being reserved at any particular time for any one arm. It is considered that it is much better practice for commanding officers to exercise their troops under difficulties, where they have always to be on the look out to avoid collisions with others, than to drill in an open ground with no obstructions. As parade displays the reviews were magnificent, and they were meant for nothing more; the troops of all arms marched past with the most perfect steadiness from first to last, and the

artillery, which has wonderfully improved in smartness, and in the quality and condition of its horses, during the last few years, trotted past in grand divisions of three and four batteries, without any loss of dressing whatever.

The exercises against a skeleton enemy were very interesting, and gave a very excellent idea as to the manner of working of the various arms, both individually and in combination one with another. The general idea for that of the 3rd Army Corps was, that a northern army (the army corps) was marching on Britz to cover Berlin, and push back a southern army advancing on the capital from Zossen.

The skeleton enemy was supposed to represent a complete army corps, containing two divisions of infantry (each having its divisional cavalry regiment and three batteries), a cavalry division of four regiments, and two batteries of horse artillery, and the corps artillery of four batteries. Each battalion was actually represented by a lieutenant, an under officer, and 20 men and a drummer, with a black and white flag. A squadron was marked by an under officer and eight men with a red and white flag, while one gun and a red flag marked each battery.



According to the special ideas, the advanced guards of both forces had come into contact early on the morning of 11th Sept., about Buchow, at which time the northern corps was disposed as follows:— The advanced guard on the *chaussée* south of Britz, about to deploy for an attack on Buchow; the main body just south of Britz, *à cheval* on the *chaussée*; the cavalry division on the right wing, and the train in rear of the main body. Cavalry patrols bring in reports that Buchow is held by the enemy, and that his main body is apparently about to advance north from Gross-Ziethen. At the same time, the advanced guard of the southern army had occupied Buchow, and was about to place it in a state of defence; the main body had entered Gross-Ziethen, while its cavalry division was at Lichtenrade, on the left, to clear the ground in the direction of Buchow.

The instructions for the fight were given by General Schwarzhof, commanding the 3rd Army Corps, to both sides as follows:—

3rd Army Corps.

1. The advanced guard takes Buchow, and covers, with its cavalry, the left wing of the army corps.

2. The 5th infantry division marches west of Buchow on Marienfelde; while the 12th infantry brigade, followed by the corps artillery, supports the attack of the advanced guard, *échelonned* to its left rear, east of the *chaussée*.

3. The cavalry division proceeds to the west of Buchow on Lichtenrade, scouting towards Gross-Ziethen and covering the right flank of the army corps.

4. The train remains in Britz.

5. The first movement to commence at 9 a.m.

6. I shall be found by the windmill, on the *chaussée* south of Britz.

Instructions for the Skeleton Enemy.

1. The advanced guard occupies Buchow, and repels one attack of the enemy.

2. At his second attack, the advanced guard is forced to evacuate Buchow, and retire on Gross-Ziethen, followed by the enemy's cavalry.

3. In the meantime the cavalry division advancing from Lichtenrade, to the west of Buchow, encounters the cavalry division of the enemy, by whom it is attacked and driven back.

4. The main body takes up a position north of Gross-Ziethen. The right wing resting on the Weinberg, and the left on a small wood west of the *chaussée*. The artillery massed in the centre, both flanks being covered by cavalry. The retreating advanced guard to form in rear of the left wing of the position, and become the reserve.

5. The enemy deploys an infantry division west of Buchow, and east of it an infantry brigade and his artillery.

6. A counter attack is made by three battalions from the Weinberg on the advancing enemy, but without success, and the former, when retiring, are assailed by cavalry.

7. The 3rd Army Corps makes a general attack on both wings, which is obstinately opposed, the reserve reinforcing the left wing.

8. The first attack of the enemy fails.

9. On his second attack, the artillery in the centre is withdrawn to a prepared position south of Gross-Ziethen.

10. The infantry retires from its position in the direction of Klein-Ziethen, followed by the enemy's cavalry, and exposed to the fire of his infantry and cavalry.

N.B.—The cavalry and artillery of the skeleton enemy are not to proceed at a more accelerated pace than a trot.

The above instructions were very accurately carried out, and though manœuvres of the kind are more tactical exercises than actual imitation of war, still the day was a very interesting one, enabling a spectator, as stated above, to obtain a far clearer insight into the *modus operandi* of the different arms, than did the great manœuvres. When the Emperor, who was accompanied by the Duke of Connaught and Duke of Cambridge, arrived at the mill, the signal to advance was at once given, and the advanced guard of the 3rd Army Corps, consisting of six battalions of the line, a battalion of Jägers, four batteries of artillery, and covered on their left by the Ziethen Hussars, pushed forward on Buchow. The latter, as usual, with the German cavalry, moved in line of squadron columns, each squadron being in column of *zugs* or divisions. Scouts were pushed far to the front and to the left. The cavalry division, with two batteries of horse artillery, advanced at the same time on the right. Directly the enemy appeared, and the scouts began to fall back, the two batteries of horse artillery forming the *reitende abtheilung*, under a major, galloped to the front a considerable distance at full speed, and taking up a position which an officer had already gone forward to select, came into action. The cavalry commander made his dispositions for attack, covered by the fire of the horse artillery, and then advanced to the charge. The batteries remained in action till their fire was masked by the advancing cavalry, the fire was then directed on any of the enemy's troops visible; directly, however, the cavalry drove back the enemy, the guns limbered up and again advanced at full speed, to cover a further advance of the former, and when, eventually, the enemy was finally driven from his position north of Gross-Ziethen, the horse artillery crowned the position, and in combination with some field batteries opened a heavy fire on the retreating enemy.

As soon as Buchow was taken, the whole of the corps artillery was brought up to some rising ground to the left of the artillery of the advanced guard, where it was massed to prepare the way for the grand attack of the main body on the enemy's position north of Gross-Ziethen. Throughout the manœuvres, this massing of artillery invariably took place when occasion rendered it feasible, the tactics of Friedland, Wagram, Wörth, and Gravelotte being repeated, and the corps artillery, always being kept in hand by the general commanding, to permit of its massing with other batteries, or forming a large battery of itself. The action of this arm was most prominent and daring, and its losses would have been very severe. On no occasion were the batteries accompanied by escorts of other arms, even when pushed to the front on an exposed flank: this appears to be exposing artillery to unnecessary risk. The whole of the equipment of the batteries are kept complete, but only four guns are horsed during peace time. It is a notable fact that no range-finders are used, which is not because they have not been tried, for they have been most fully so, but they have been found difficult to keep in adjustment, and most uncertain in their results. Batteries always commence firing at practice at unknown ranges with trial shots; and if the result of their shooting is to be accepted as worth anything, they certainly expend very little ammunition indeed, before they discover the actual length of their range.

On the 14th Sept., the Garde Corps was also exercised against a skeleton enemy, under the following general idea :—

The Garde Corps, on the 13th Sept., has crossed the Spree, and, on the 14th, is to leave the positions then taken up to the south of Rudow and, moving on Marienfelde, unite with an army which is operating from the south. The Garde cavalry reached Gross-Ziethen on the evening of the 13th Sept., and reports that Buchow is not held by the enemy, and that Britz and Mariendorf are only lightly occupied by him.

A northern force (*markirte feind*) will operate offensively against the Garde Corps from the line Britz-Mariendorf.

Dispositions for the 14th Sept., 1880.

Garde Corps.—Head-Quarters, Rudow.

13th Sept., 1880.—9 p.m.

The enemy's outposts occupy the line Britz-Mariendorf; my purpose is to gain possession of Marienfelde to-morrow, under the following arrangements :—

First.—The 1st infantry division with the corps artillery will march upon Marienfelde by Buchow, at 8 a.m.

Secondly.—The 2nd infantry division will break camp at 7 a.m. and march by Gross-Ziethen and Lichtenrade.

Thirdly.—The cavalry division will cover the movement to the north of Buchow in the direction of Britz and Mariendorf. Two batteries of horse artillery will be attached to the cavalry division. An attack is to be looked for on the part of the enemy.

I shall be found at the head of the 2nd infantry division.

(Signed) AUGUST,

Prince of Wurtemberg.

The skeleton enemy was represented by—

The infantry battalion of instruction.
Three companies of the Garde pioneers.
The Jägers of the Garde (1 battalion).
Two companies of the under officers school of instruction, Potsdam.

The 5th squadrons of all the cavalry regiments, except the Hussars of the Garde and the 2nd Uhlans of the Garde.

The battery of instruction.

One battery of horse artillery.

The above represented a force of 17 battalions, 24 squadrons, and eight batteries; while the Garde Corps contained 28 battalions, 34 squadrons, 16 batteries.

Rendezvous:—

The cavalry division with two batteries of horse artillery in the space within the fork formed by the junction of the Buchow-Lichtenrade, Lichtenrade-Mariendorf roads.

The 2nd infantry division on the Weinberg, south of Gross-Ziethen.

The 1st infantry division and the corps artillery in the fork of the roads Buchow-Rudow, Rudow-Rixdorf.

The corps is supposed to be in columns of march. The first gun fired by the *markirte feind* is to be taken as a signal for the general action to begin.

Stages of the Fight.

1st. *Markirte Feind.* One infantry division marches from Mariendorf, and an infantry brigade from Britz towards the south, while the cavalry division on the right wing marches on Lichternade.

Garde Corps. The 1st division marches on Buchow, the 2nd division against Mariendorf; the cavalry division on the left flank drives back the enemy's cavalry in the direction of Mariendorf.

2nd. *Markirte Feind.* The advanced guard of the northern corps reaches some rising ground north-west of Buchow.

Garde Corps. The Garde Corps drives in the enemy's outposts along the whole line.

3rd. *Markirte Feind.* The northern corps deploys on the line Britz-Marienfelde, and throws up light earth-works to strengthen his position.

Garde Corps. The 2nd division deploys for an attack on the enemy's right wing. The 1st division and corps artillery reach Buchow.

4th. *Markirte Fiend.* The right wing opposes a stubborn resistance, and attempts a counter attack.

Garde Corps. The 2nd division and corps artillery unite with the 1st division.

5th. *Markirte Feind.* The counter attack of the northern corps fails.

Garde Corps. The 2nd infantry brigade, 1st division, reinforces the 2nd division, which drives in the right wing of the enemy. The 1st infantry brigade proceeds to attack Britz.

6th. Hard fighting about Britz.

7th. *Markirte Feind.* General retreat of the northern corps in the direction of Rixdorf.

Garde Corps. The 1st division occupies positions vacated by the enemy, and the 2nd division forms in *échelon* in rear of the left flank.

8th. *Markirte Feind.* The cavalry covers the retreat.

Garde Corps. The Garde cavalry division disperses the enemy's cavalry.

The field of operations lay about 15 miles south of Berlin, and was the same sandy plain as that manœuvred on by the 3rd Corps. Through this plain two high roads or *chaussées* lead from Berlin to the south. The eastern one passes through Britz, about 15 miles south of Berlin, and about two miles further south through Buchow; the second road runs about two miles to the west of the former, and, at about the same distance from the capital, passes through Mariendorf.

The operations began with a very fine charge of cavalry in three lines, supported by horse artillery; the first consisted of two Cuirassier regiments, with two squadrons of Uhlans 150 yds. in rear in support of each regiment; the second of the remaining six squadrons of two Uhlan regiments *échelonned* on the exposed flank, and the third of two regiments of dragoons *échelloned* on the inner flank. The charge, which was supported by two batteries of horse artillery, was very well executed, and at the signal to halt, the various lines pulled up, and not a horse was seen out of his place in the ranks. The advance of the horse artillery had been made at a very rapid pace, and it came into action at least 1000 yds. in advance of its cavalry.

When the enemy's cavalry had been driven in, the left brigade of the Garde infantry rapidly advanced—its two regiments side by side. Each regiment had two companies extended, and two in support; while its second battalion formed the reserve, and its third the second line. The supports remained in company columns of *zugs*, or sections, till they reinforced; the reserve advanced in line, and the second line in company columns. The attack of this brigade did not succeed, and, when it could gain no more ground, the entrenching tools, of which 50 spades, 5 picks, and 5 axes are carried per company, were brought into use, and slight trenches made with great celerity. The 3rd brigade then came up to reinforce, but still without success; the whole of the corps artillery in line was then brought up on the right of the infantry to support the attack, and the 2nd infantry brigade also reinforced; their combined efforts were sufficient, and the enemy was driven in and his right flank turned. When the success of this movement was pronounced, the 1st infantry brigade advanced against Britz, supported

by the divisional artillery of the 1st division, and protected on the right by its divisional cavalry. One regiment attacked the village in front, the other on the left; and the enemy, the rest of whose force was being driven in the whole length of the line, evacuated the village in hasty retreat. The day was brought to an end by another very fine charge of the victorious cavalry on the enemy's cavalry and batteries which were covering the retreat.

The 15th September was a day of rest; but, on the morning of the 16th, the real work of the manœuvres commenced, and very early indeed in the morning the troops, who were to bivouac *à la belle étoile* for the next two nights, left their quarters and proceeded to their respective rendezvous, according to the general idea which had been issued for the forthcoming three days' fighting. Very long indeed were some of the marches which had to be made, but in such excellent condition were the troops, and so inured to marching, that no cases of men falling out of the ranks occurred. In the field batteries all the gunners walked, except the Nos. 1*; no men even being carried on the carriages except when manœuvring at a trot.

The general idea was as follows :—

On the supposition that Berlin is only weakly occupied, a southern army (the 3rd Army Corps) is conveyed northwards by rail, on the Zulow canal, to attack it, and, on the 15th September, has taken up position on the line Königs-Wusterhausen, Mittenwalde, and Great Macknow.

A northern army (Garde Corps) marches from Berlin to meet the enemy. The northern boundary for the operations of the 15th Sept. is Teltow, Marienfelde Rudow, which places may be occupied by the Garde Corps.

The special idea for the southern corps was that, in consequence of its commander expecting reinforcements to arrive by the Dresden railway, he was to take steps to ensure the safe arrival of the same at Great Macknow, by taking up positions, and holding the ground to the north of that place, between it and the enemy.

Rendezvous for the 16th Sept., on the line Blankenfelde-Selchow. The first movement to commence at 8.45 a.m.

The following orders were consequently issued by General von Schwarzhof, commander of the 3rd Army Corps :—

The army corps has the task of securing the safe arrival of its reinforcements at Great Macknow, I therefore intend to march to encounter the enemy, whom I know to be on the move in this direction from Berlin, but as to whose strength I have as yet received no information whatsoever.

1. At 8.30 a.m. on the 16th Sept., the troops will be ready to march off in the following order :—

The cavalry division at the east entrance to Selchow, east of the road leading to Rotzis.

* Called in Germany "Captain of the gun."

The 5th infantry division at the southern entrance to Selchow, on the road from Brusendorf.

The 6th infantry division, to whom the Jäger battalion is attached, at the southern entrance of Glasow on the *chaussée*.

The corps artillery in rear of the 6th infantry division.

The train at the southern entrance from Dahlewitz.

2. Each division will furnish its own advanced guard, and the advanced guards of the infantry divisions will take up positions at the northern exits of Selchow and Glasow.

3. At 8.45 a.m. the cavalry division will proceed to reconnoitre the enemy in the direction of Gross-Zeithen and Lichtenrade, and thence towards Berlin; will hold the defiles leading south from the two former places till the arrival of the infantry divisions, and will secure the army from flank attack from the direction of Rudow.

At the same time the 5th infantry division will march on Klein and Gross-Ziethen and protect the right flank of the army from attack from the direction of Schönfeld and Rudow; while the 6th infantry division will march on Lichtenrade and protect the left flank of the army from attack from the direction of Mahlow and Marienfelde.

The corps artillery will proceed by Glasow on Klein-Ziethen, following the 5th infantry division.

The train will remain at Dahlewitz.

Each infantry division will leave a company of pioneers at Glasow and Selchow respectively, under the command of Major von Langenbech of the general staff, in order to throw bridges across the Luch, and to protect them by slight earthworks thrown up in advance.

I shall be found at the head of the main body of the 6th infantry division.

(Signed) VON SCHWARZHOF,

General Commanding.

The special idea for the Garde Corps for the 16th Sept., was—

The northern corps will drive its weaker enemy back over the Zulow canal. Rendezvous for the 16th Sept., on the line Britz-Lankwitz. Movements to commence at 9.15 a.m.

The following orders and instructions were issued by the commander of the northern corps, Prince August of Wurtemberg, who commanded the corps on the celebrated day of Gravelotte.

Garde Corps.—Head-Quarters, Berlin.

15th Sept., 1880.—6 p.m.

An army corps of the enemy, which has been conveyed by rail from the south, has taken possession to-day of the line Königs-Wusterhausen,

Mittenwalde, Great Macknow. The Garde Corps will march to-morrow to his encounter, and throw him back over the Zulow canal.

The cavalry division will assemble east of Britz, on the Rixdorf-Rudow road, and at 9.15 a.m. proceed against the line Königs-Wusterhausen, Mittenwalde, Great Macknow. It will endeavour to gain all the ground it can to the front, to obtain information of the enemy, and hold, temporarily, commanding points of ground.

The 1st Garde infantry division will rendezvous south of Mariendorf, and at 9.15 a.m. march by Lichternade and Glasow on Great Macknow.

The 2nd Garde infantry division will rendezvous south of Britz, and at 9.15 a.m. will march on Mittenwalde by Gross-Ziethen and Selchow.

The combined brigade will rendezvous south of Lankewitz, and at 9.15 a.m. march on Mahlow by Marienfelde.

The corps artillery will rendezvous south of Britz, in rear of the 2nd division, and follow the leading brigade of the latter.

I shall be found at the head of the 1st infantry division.

(Signed) AUGUST,

Prince of Wurtemberg.

The Garde Corps was composed of 30½ battalions, 40 squadrons, and 18 batteries; of these the combined brigade was formed of—

Garde fusilier regiment. Infantry battalion of instruction.	4½ battalions.
Two companies under officers school of instruction, Potsdam.	1 squadron.
One squadron Hussars of the Garde. Instruction battery, school of gunnery.	4 guns.

The railway, to defend a portion of which the whole efforts of the commander of the southern army were centred, runs due south from Berlin over a wide, sandy, but cultivated plain, intersected by many roads, which were distinguishable from a considerable distance by the poplars which, as with most continental highways, lined both sides of them; few other trees were to be seen, except those clustered round the villages, which were sparsely dotted about and noticeable by their lofty spires.

The extreme points of the outposts of either side were only about five miles apart, so that very shortly after the signal to commence hostilities was given, the scouts came into contact with one another. Both sides pressed on, and when the advanced guard of the right, or 5th division 3rd Army Corps, had reached the village of Gross-Ziethen and occupied some rising ground to the south of it, they discovered the left of the Garde Corps, flanked by a large body of cavalry, advancing in great strength on the village. Intelligence was at once sent to the

corps commander, and the advanced guard proceeded to strengthen their position by means of shelter trenches in *échelon* to one another, and by digging gun pits for the guns of the battery attached to it, and also for the three remaining batteries of the division, which were quickly hurried up to reinforce. These pits were dug by pioneers, a number of whom were always with advanced guards, and who, in the loose sandy soil, quickly accomplished their work. The trenches dug by the infantry were very shallow, and only calculated to shelter men lying down. No doubt, in a case like the present one, where a small body is called upon to hold a position against superior numbers till its reinforcements arrive, the spade is of real practical utility; it would not, however, appear desirable to accustom men to use it on every possible occasion, or they would soon be led to believe that they could not safely dispense with its use, and delay and disaster might be the result.

On this day, however, both infantry and guns were fairly under cover before the enemy approached to anything like striking distance. The Garde Corps commenced their attack by a grand cavalry charge, supported by two horse artillery batteries. They advanced in the same formation and order as before described, and pulled up a very few yards from the muzzles of the guns and from the infantry shelter trenches; the action of the second line was well illustrated by their wheeling sharply to the left and meeting the charge of the 3rd corps cavalry, which endeavoured to take their own first line in flank, the third line, in the mean time, having a portion in reserve, closed up to the first. The Crown Prince and other umpires who were on the spot deliberated for a few moments, and then gave it as their decision that the charge was partially successful, that the guns had been reached and were so disabled that they must be withdrawn, but that the cavalry in their turn had suffered such losses that they must retire.

The Garde infantry had now approached, supported by four batteries; and the enemies infantry, now without the aid of guns, were ordered back on the village of Gross-Ziethen, which was now held in strength by the main body, and had been partially put into a state of defence; this they held obstinately, till their left was also driven in by the 1st Garde division, supported by the combined brigade; these pressed on and took the village of Lichtenrade, which made Gross-Ziethen untenable; a stand was made by the infantry on the road between these two villages, while the corps artillery was massed on some rising ground to the south of it, with woods to its left and rear, to cover the retreat. These batteries must have suffered severely, and probably many of the guns would have been taken, for after the infantry had retired beyond them, they still remained in action, and were closely approached by some of the enemy's riflemen, who advanced through the woods on the left of the batteries. Had the latter been provided with a strong infantry escort this could not have happened, for the latter would have held these woods for a time, and have enabled the guns to retire without loss.

The whole 3rd Corps was now in full retreat, which was molested by two regiments of cavalry, which crept up on the left of their own

infantry under cover of the woods, and executed in succession two very well timed charges. The retreating infantry turned about and received them in line, and then the signal to cease the proceedings was given. It is understood that a decision adverse to the cavalry was given; but as the infantry they charged was pressed by infantry, and fired upon by artillery, while they themselves had no support from their own guns, the charge would at least have thrown them into considerable confusion, and probably have inflicted serious losses.

On the 16th September, the Garde Corps had performed part of its task, viz., to push back its numerically weaken enemy on the Zulow canal, for the latter had been forced to retire from the line Lichtenrade-Gross-Ziethen, where it had first attempted to stop the advance of the Garde Corps, to the southern side of the defiles leading across the line Selchow-Glasow.

The following orders after the close of the day's fighting were given by the commander of the 3rd Army Corps:—

1. The army corps having retired behind the defiles on the line Selchow-Glasow, will bivouac as follows:—

The 5th Infantry Division	South of Selchow.
The 6th Infantry Division, and Corps Artillery	South of Glasow.
The Cavalry Division	About Rotzis.

2. Each infantry division will furnish its own outposts (strength, one infantry regiment, one cavalry regiment and one battery;) these will be posted north of the above line, which will be strengthened for defence by means of shelter trenches. The 5th infantry division will cover the right flank of the army, and watch the approaches from Diepensee, Schönefeld and Rudow, while the 6th infantry division will guard all the approaches to their front and left, on which side the railway crossings and approaches from Blankenfelde will be rendered impassable.

(Signed) VON SCHWARZHOF,

General Commanding.

Dispositions of the 3rd Army Corps for September 17th, 1880:—

The enemy's outposts hold the line Mahlow, Klein-Ziethen. My object is to prevent him from gaining possession of the defiles on the line Selchow-Glasow.

1. The outposts will defend to the utmost their positions north of this line, and if forced to retreat, will contest every inch of ground.

2. To-morrow, the 17th Sept., at 9.30 a.m., the army corps will be in readiness to commence operations, and will be in position as follows:—

The cavalry division in rear of the right wing of the outposts of the 5th infantry division, east of Selchow.

The 5th infantry division on the Selchow-Brusendorf road, on the southern slopes of the Hunenberg.

The 6th infantry division on the Gross-Kienitz-Selchow road, on the southern edge of the Gross-Kienitzer-Berge.

The corps artillery in rear of the 5th division.

3. The defiles on the line Selchow-Glasow are to be put into a state of defence on the southern side.

4. Should the outposts be driven in, those of the 5th division will retire along the Selchow-Brusendorf road, and those of the 6th along the Glasow-Dahlewitz *chaussée*.

5. The 6th infantry division will detach a company of pioneers with cavalry patrols to watch the destroyed crossings about Blankenfelde, and to prevent the enemy from repairing them; a company of pioneers will also be detached from the same division to occupy the line of railway from Great Macknow.

6. My position will be at the head of the 5th infantry division.

The same evening the General commanding the Garde Corps issued these instructions:—

Position of the Garde Corps on the evening of the 16th September.

Combined brigade at Mahlow.

1st Garde infantry division and corps artillery at Lichtenrade.

2nd Garde infantry division at Gross-Ziethen, cavalry division at Rudow.

The outposts occupy a line from the south of Mahlow, over Klein-Ziethener-Berg, Bolkens-Berg, &c., to the eastward.

To-morrow, the third horse artillery battery will also be attached to the cavalry division.

Disposition of the corps for the 17th September.

Garde Corps.—Head-Quarters, Lichtenrade,

16th Sept., 1880.—5 p.m.

To-day the Garde Corps has fought a victorious engagement with the enemy, and driven him back through the defiles leading to Glasow, leaving only his outposts north of the same.

My object is to resume the offensive, to-morrow, by out-flanking the enemy's right wing.

1. The Garde cavalry division will march to-morrow at 9.30 a.m., and, passing to the east of Schönefeld, will hang on the right flank of the enemy, and prevent him from pushing forward reconnaissances along the line Wasmannsdorf-Kiekebusch.

2. The combined brigade will leave Mahlow at 9.30 a.m., will hold the road Lichtenrade-Glasow, and hold the defile leading from the latter place.

3. The 1st division will move forward at 9.30 a.m., one brigade marching on Weinberg, south-west of Selchow, and the other, followed by the corps artillery, on Selchow *viâ* Klein-Ziethen.

4. The 2nd division will march at 9.30 a.m. by Schönefeld and Diepensee on Rotzis.
The rifle battalion (*Garde-Schützen bataillon*) will be detached to escort the corps artillery (six batteries).

5. My position will be at the head of the infantry of the left column of the 1st division.

(Signed) FRIEDRICH FRANZ.

The outpost services were conducted in every respect as they would have been in actual warfare. Constant patrols had been on the move during the night on both sides, and these had repeatedly come into contact with one another; the two Hussar regiments, viz., the Hussars of the Garde and the far-famed Ziethen Hussars, of whom the Duke of Connaught is Colonel, and whose uniform he wore throughout the manœuvres, were especially active in patrolling and scouting. Directly the signal to commence was given, the space intervening between the two outposts was dotted over by them, and as their uniforms are both red, it was not easy to distinguish one from the other. The attack began by an advance of the combined brigade on the enemy's left; but here little ground was made, for, from the railway to the defile, entrenchments had been dug, and these were further protected by a stream, which made the position perfectly unassailable by a front attack. The 1st division gradually succeeded in pushing back the outposts of the enemy and occupying the defiles, and after one failure it carried the village of Selchow. At this period the commander of the Garde Corps perceiving a gap to exist between the divisions of his enemy, attempted by a rapid forward movement to pierce his centre, and this he nearly succeeded in doing; General Schwarzhof averted the catastrophe by a very rapid massing of eleven batteries on the Hunenberg, six being his corps artillery, four the divisional artillery of the 6th division, and one battery of the 5th. He thus repaired the gap in his line, and checked the advance of his enemy with an overwhelming fire. The advantage of the corps artillery being at

hand and at the prompt disposal of the commander could not possibly have been better illustrated than on this occasion, and the great celerity with with which the batteries concentrated and took up their positions on one long line, is worthy of all praise.

On the right of the 3rd Corps several skirmishes had taken place between the cavalry of both sides, that of the Garde striving to cover the flank march of the 2nd infantry division, while that of the 3rd Corps endeavoured to discover what was going on about its right front; one charge in force was made, which was given against the latter, whose scouts, however, succeeded in ascertaining that a large body of infantry was moving to the right of their position. Information was at once sent of the movement, and all available force was moved to the threatened side; when, at last, the attack was made, it was met with twelve batteries, the 5th infantry division, with the cavalry division *échelonned* on the right rear. It appeared very doubtful whether the attack would not have failed against such a force so strongly posted, and had it failed, and a rapid counter attack been made by the 3rd Corps, the latter would have pierced the centre of its opponents line and separated his two wings, which at this time were a long way apart; for, it should be remarked, the commander of the 3rd Corps maintained his hold on the railway, where his left was strongly entrenched, and from this to the Hunenberg and Rotzis, throughout the day; had he then made a rapid counter attack, and succeeded in re-taking the village of Selchow, his enemy's situation would have been precarious in the extreme. At this period the signal to cease fire was given by command of the Emperor, and the troops for a second time went into bivouacs for the night near the positions last held by them on the field of battle.

On the 18th September, the third and last day of the grand manœuvres, the tables were turned, and the commander of the southern corps received his long looked for reinforcements of 4½ battalions and one battery, while the northern force was weakened to the same amount, owing to its commander being compelled to detach a body of troops to protect Spandau. According to the special ideas, the former officer was at once to assume the offensive, and drive his opponent back on Berlin, while the latter was directed to resist his forward movement to the utmost.

The orders for the 3rd Army Corps were :—

17th Sept.—1.45 p.m.,

On the Heights near Brusendorf.

1. Outposts will be posted as follows :—

Those of the 5th division on the right from Carlshof to height marked 140, south-east of Gross-Kienitz.

Those of the 6th division from the above heights to the Rangsdorfer See.

Each division will furnish for outpost duty one infantry and one cavalry regiment, and a battery; the remainder of the corps will bivouac as follows:—

5th infantry division, with the cavalry division in its rear, south of Brusendorf.

6th infantry division, with the corps artillery and train in its rear, south of Klein-Kienitz.

Head-Quarters, Klein-Kienitz.

17th Sept., 1880.—3.45 p.m.

The enemy's outposts occupy the line Glasow Gross-Kienitzer-Berge.

On the arrival of my reinforcements I intend to attack the enemy, and throw him back on Berlin.

The army corps will be in readiness to move off at 9.30 a.m. to-morrow, in the following positions:—

1. The cavalry division in rear of the outposts on the right, near Rotzis.

The 5th infantry division in rear of the outposts, in the Brusendorf-Selchow Road.

The 6th infantry division in rear of the outposts on the Klein-Kienitz Gross-Kienitz Road.

The combined brigade (which represented the reinforcements) south of Dahlewitz.

The corps artillery in rear of the 5th infantry division.

The train will remain for a time in its bivouac.

2. At daybreak the commander of the outposts will push forward a reconnaissance, to ascertain if the enemy still holds his former positions.

3. I shall be found at the head of the 6th infantry division.

(Signed) VON SCHWARZHOF,

General Commanding.

At the close of the battle of the 17th, the Garde Corps was disposed as follows:—

Combined brigade north of Glasow.

1st division and corps artillery about Selchow.

2nd division about Rotzis.

Cavalry division about Waltersdorf.

Outposts were thrown out, and occupied a line from the south of Glasow, over the Gross Kienitzer-Berge to the east.

On the evening of this day the commander, having been compelled to detach 4½ battalions and a battery to Spandau, issued these orders :—

Garde Corps.—Head-Quarters, Lichtenrade,
17th Sept.—5 p.m.

The enemy, whose outposts occupy the line Dahlewitz-Gross-Kienitz and eastwards, has received reinforcements of infantry and artillery.

The Garde Corps must be prepared to meet an offensive movement on the part of the enemy on the line Marienfelde-Britz.

1. The 2nd division will direct itself to-morrow at 9.30 from the west of Wassmannsdorf by Lichtenrade on Mariendorf.

2. The 1st division, whose outposts will remain in their positions, will as a preliminary measure, at 9.30 to-morrow morning, hold with one brigade the defile from Glasow, and with the other the position on the Weinberg, and the ground south of Selchow. The Garde Pionier Battalion will be directed to prepare for defence a position extending from Britz to the height marked 156, west of the Lichtenrade-Mariendorf road.

3. The cavalry division will reconnoitre to-morrow, at 9.30 a.m., from Rotzis towards the enemy's right, and afterwards cover the retrograde movement of the corps.

4. The corps artillery will at the same hour be in position south of Klein-Ziethen.

5. I shall be found from 9.30 a.m. on the Klein-Ziethener-Berge.

(Signed) FRIEDRICH FRANZ.

Although the southern force had been pushed back in the two days' fighting of the 16th and 17th from the line Lichtenrade-Gross Ziethen as far as the line Dahlewitz-Klein Kienitz-Brusendorf, still its commander never for an instant slacked his grasp on the line of railway, which according to the general idea it was his task to hold on to and defend. His left, therefore, being his fixed and most important flank, he had strongly and most skilfully entrenched it on the railway line, and all efforts of his enemy had failed before his stubborn resistance. As on the first two days, firmly pivoting on his left, he had been forced to throw his right and centre back before the onslaughts of superior numbers, so on the third day, on receiving his reinforcements and becoming in his turn numerically superior, he pivoted on his left, and swung his right and centre forward to drive the Garde Corps back on Berlin.

The commander of the latter corps on finding himself weaker than his foe, determined to retire to a strong and prepared position on the

line Marienfelde-Britz, covering the movement with his powerful cavalry division. The action commenced, as usual, with frequent skirmishes between the cavalry patrols, the Ziethen Hussars eventually driving in the Garde Hussars, who were covering the withdrawal of their infantry outposts; the advanced guard of the 3rd Corps advanced with great rapidity, occupied the defiles north of Glasow, the Gross-Kienitzer-Berge, and the Hunenberg, which they quickly cleared of the enemy, who sustained a mere delaying fight till they came to the village of Selchow and the woods on the west of it, between it and the *chaussée* leading from Glasow to Klein-Ziethen. Up to this time only the advanced guard of the 3rd Army Corps had been engaged, but here the resistance offered was so stubborn, that the main body was called into play. The 5th division with the cavalry on the right deployed for an attack on Selchow, which they forced, and then drove the enemy before them through Wassmansdorf; in the meantime the cavalry, supported by three batteries of horse artillery, which came into action on the roadway east of Selchow, drove the Garde cavalry through Diepensee and Schönfeld, whence the latter retired on Gross-Ziethen, and took up a position near that place to cover the left of their corps, which after being driven through Wassmansdorf, changed position, left back, pivotting on their right, which, contesting every yard of ground, was now in position on the west of the woods south of the Bolkens-Berg; this retirement and change of position was exceedingly well carried out, and so rapidly, that though the two corps had been—very shortly previous—at very close quarters to one another, a considerable interval was now left between them. The new front taken up by the Garde Corps was about two miles in length; its centre—where six batteries were massed—rested on the Bolkens Berg, its left occupied the high ground east and south of Gross-Ziethen, while its right held Klein-Ziethen, and the rising ground east of it. The 3rd corps now occupied the Rudow-Wassmansdorf road from the north of the former place as far as the cross roads, with the cavalry on the right, and nearly all the guns concentrated on the centre. The grand attack on the position of the Garde Corps was now made. After a preliminary cannonade, the cavalry division was hurled against the enemy's left. The infantry charged was unbroken, the cavalry had to cross a long open space, fully exposed to fire, and though they would probably have penetrated the hostile position, still it must be doubtful whether the enormous losses they must have sustained would have been at all compensated for by any success they may have gained. Besides, the occasion did not seem to call for such a sacrifice, as the 3rd corps was gradually gaining the advantage; and a steady advance of the infantry, supported by their powerful artillery, would have attained the same end at a much less cost, while the cavalry would have been unbroken and ready to pursue and harass the beaten enemy retiring in confusion from their captured position. As a spectacle the cavalry charge was magnificent; it was led as usual by two regiments of Cuìrassiers in the front line, two of Uhlans in the second, and two of Dràgoons in the third. The infantry on the right of the 3rd Corps followed the cavalry, and the left of the Garde was driven in, and commenced to retire on

Britz, their right also evacuated Klein-Ziethen, and retreated on the prepared position between Mariendorf and Britz; while the centre—where, as before stated, many batteries were posted—held on to Bolkens-Berg apparently much too long, for both its flanks were actually passed by the enemy, who would have captured nearly the whole of it, had not at this period the signal been given by the Emperor to cease firing, which brought to an end the manœuvres of 1880.

The critique on the whole of the proceedings was then given by the Emperor, after receiving the reports of the generals in command, and the umpires. The Duke of Connaught, Sir Garnet Wolseley, and officers from nearly all the armies of Europe were present.

Artillery.

The great improvement which has taken place in the German artillery, both as to its equipment and horses, in the last few years, was a subject of general remark. Though, even at the reviews, there was not much sign of a burnisher having been used, the iron work was all kept clean and free from rust, and the whole turn out eminently suggested the idea of thorough serviceableness. The batteries, both horse and field, acted admirably in combination with the other branches of the service to whom they were attached. Their action was most thrusting; and no attacks of any importance was made by either cavalry or infantry which were not preceded by a rapid advance of guns, which, utterly regardless of all other objects, brought their fire exclusively to bear on the position or troops about to be assailed by the former. Positions were taken up by the guns at a very rapid pace, and though when moving over rough ground the long pole seemed to sway dangerously, and looked as if it must bear the wheelers down, no accidents of any kind occurred throughout the manœuvres, which speaks volumes, for though the country was open, and as a rule flat, it was intersected in every direction by ditches, which were always crossed as they came, without loss of pace.

The field artillery equipment of Germany has been so exhaustively set forth in a pamphlet of Capt. Wille, of the Foot Artillery, translated in 1877 by Major Fairfax Ellis, R.A., that it would be superfluous to treat of it here; the following points, however, in which a difference exists in this arm in England and Germany will be of interest to artillerists.

Brakes are used on both the gun carriages and wagon bodies, without exception, and are found to answer perfectly.

Axletree-seats are only applied to the heavy or field artillery guns, they are provided with indiarubber washers to diminish jolting. The limber boxes are provided with wooden backs which greatly conduce to the safety and comfort of the gunners seated thereupon. The limber-hook is attached to a futchel which protrudes considerably beyond the rear of the limber.

Saddles are carried by all the off horses, on which the cloak and other articles of kit are fastened. A blanket is folded in six or more thicknesses, and placed on the horse's back. On this rests the saddle, which consists of a tree without panel, the pommel and cantle being made very strong of iron arches, the horns are of wood, and a broad strip of stout leather passes from cantle to pommel, laced with leather to the horns; the pad (*Kissen*) is placed on the tree, a saddle cloth or shabracque on it, the whole being made fast with a surcingle. The girths and stirrup leathers are of course fastened to the tree. The *Kissen* is of considerable size, and in the front part of it are two pockets, in which the scanty kit is carried. There is no difference between the off and riding saddles, except that no stirrups were carried on the former. The cloak is fixed in rear of that of the off horse.

The batteries are nearly always worked three or four together, which form a division (*abtheilung*), under a Major or Lt.-Colonel; when the troops, whose advance the guns supported, passed the latter, that officer accompanied by an adjutant and orderlies, followed the advance at a distance, to ascertain how he might best support it by ulterior movements of his batteries; directly the result of the attack was apparent, orders were sent by him to the rear, either to advance and occupy the captured position, or in case of failure to be prepared to cover retreat.

When guns came into action, one round was quickly fired, but afterwards the firing was very slow indeed. Flags of different colours, according to the nature of troops aimed at, were hoisted in the batteries, which seems to be a plan well worth adopting; ammunition is saved, while a far better guide is furnished to the umpires as to the object of the guns, than by firing any number of rounds.

The No. 1 in both horse and field artillery always rides on the off side of the gun leaders; in action his horse is held by the centre driver. In the horse artillery there are no limber gunners, every man is mounted; the front rank consists of four, the rear rank of three men, there are two horseholders one of whom in action holds three, the other, two horses, besides his own; the detachment is always posted in rear of the gun.

In action, to ensure quickness in limbering up, the limbers are not reversed, and the horses stand with their backs to the enemy. This does not appear to be a good arrangement, for it is difficult to get horses to stand steady when thus placed; while if a limber were blown up, the result to the detachment in close proximity to it would be most disastrous.

In both horse and field artillery long cavalry swords are carried by all mounted men, drivers included, the gunners in the latter are armed with sword bayonets. In war, pistols also are carried by mounted men.

Infantry.

The present mode of attack by an infantry brigade is as follows:— A brigade consists of two regiments; a regiment of three battalions; a battalion of four companies. The two regiments advance side by side. The leading battalions extend, as a rule, two companies as skirmishers, which are followed at about 200 paces by the remaining

companies in company columns of *zugs* or sections as supports. The second battalions follow the supports at about 400 paces, with its companies in line. The third battalions follow at about 500 paces, with its companies in company columns. The skirmishers advance by alternate rushes (*sprungweise*), taking advantage of all cover. When the supports reinforced they fired volley after volley. The development of volley firing is much studied at the present time in Germany. A magazine or repeating rifle, (the ordinary Mauser, converted on the Löwe system) which has already been issued to all four companies of the Rifle Battalion (*Schützen Bataillon*) of the Garde, and which in trained hands is capable of firing 12 rounds of aimed fire in 35 seconds, will enormously increase the moral and actual effect of volleys. This weapon has been tried with the most satisfactory results at the School of Musketry at Spandau. It is, however, rumoured that the troops to whom it has been given by no means approve of the new weapon, as the receptacle for the 12 cartridges greatly increases the weight, and the extraction of the used cartridge is attended with some difficulty.

Cavalry.

The attack of a cavalry division of six regiments is thus conducted:—

The division is formed into three lines (*Treffens*) of two regiments each.

The first moves forward in squadron columns of $\frac{1}{4}$ squadrons (*zugs*) at deploying intervals, till it deploys into line for attack.

The second line follows the first at a distance of about 300 yds. in *échelon* on the exposed flank; it usually moves in quarter-distance columns of regiments, till the first line deploys for attack, when it forms squadron columns of *zugs* at deploying intervals; two squadrons are detached as supports to the first line, in rear of the centre of each regiment, of which one follows in line at a distance of about 150 yds.

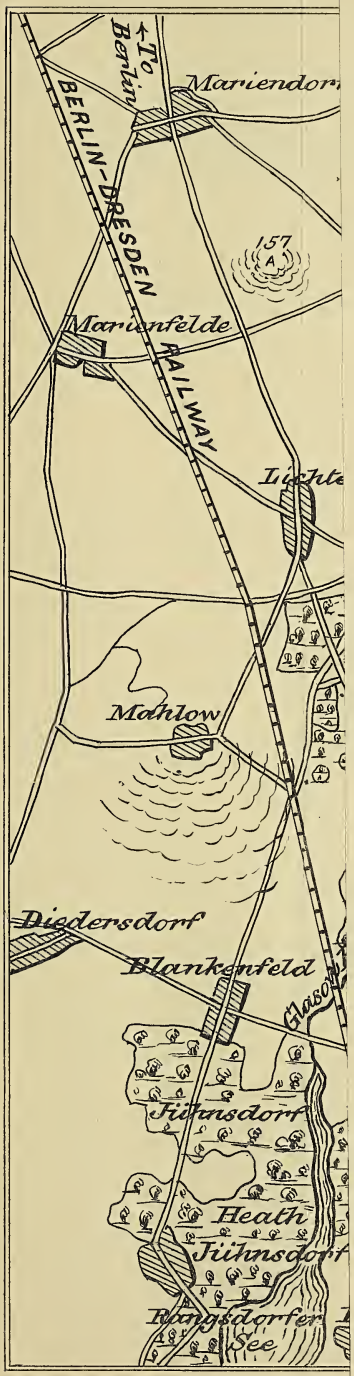
The duty of the second line is to protect the exposed flank of the first, and also to act on the flank of the enemy.

The third line follows about 450 yds. in rear of the first in *échelon* on the inner flank. It usually advances in quarter-distance columns of regiments, with or without deploying interval between the two. This line composes the reserve, and when the second lines comes into action it forms itself into squadron columns of *zugs* at deploying intervals, and takes the place of the former. Under no circumstances whatever does it reinforce without leaving a portion of its squadrons in rear as a final reserve.

Each line advances with scouts in front, and small patrols to cover the flanks.

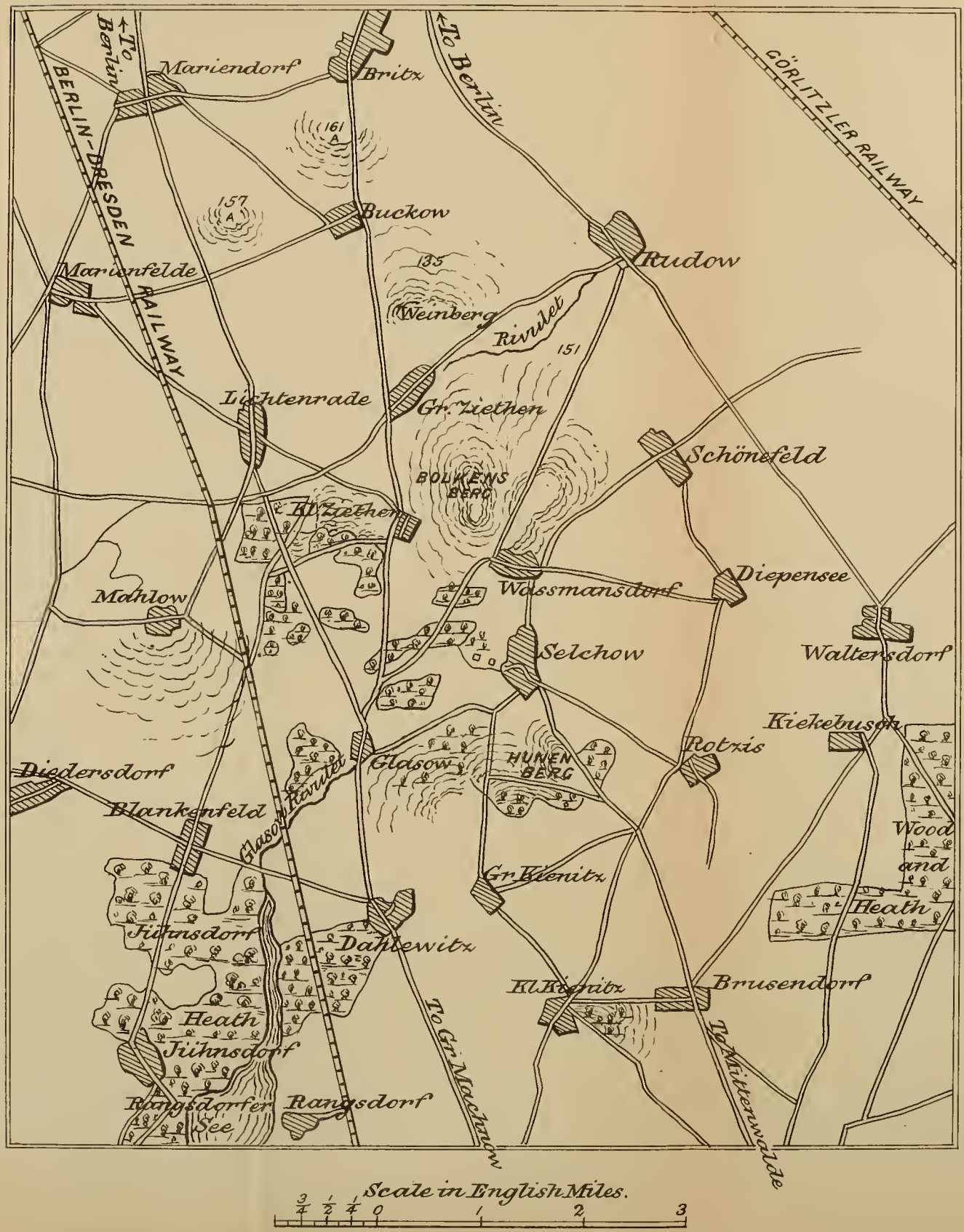
I cannot close this paper without expressing a deep sense of the magnificent hospitality shown to the officers of foreign armies, who were present as guests at the manœuvres, by His Majesty the Emperor of Germany and the Crown Prince. I must also gratefully testify to the excessive courtesy which we met with from every officer of the German army with whom we came in contact.

MANŒUVRES
CORPS OF TH



MANŒUVRES OF THE GARDE CORPS AND III ARMY CORPS OF THE GERMAN ARMY. SEPTEMBER 1880.

MAP.



THE DEFENCE OF EKOWE.

BY

LIEUT. W. N. LLOYD, R. H. A.

On New Year's Day, 1879, No. 1 Column, under the command of Colonel C. K. Pearson, was encamped at Thring's Post, 24 miles from the Lower Tugela drift, better known as Fort Pearson.

At this time all hope of King Cetewayo complying with our conditions had been set aside, and our column was under orders to march to the Lower Tugela drift on 3rd January; should no signs of compliance on the part of the King be visible by 11th January, we were to cross the river into Zululand.

On 12th January, at daybreak, the passage of the river commenced, but it was not till the 16th that the whole column was encamped in the enemy's country. On Saturday, 18th, at 5 a.m., our column commenced its forward march, the troops being in excellent spirits and eager for the fight which we well knew was at hand. Everything progressed in the most satisfactory manner until the 22nd, for although we had, up to this time, observed the Zulu scouts watching our movements from the hills in front, yet we apprehended no imminent danger. However, on that morning we marched as usual at daybreak and all went on quietly until 8 o'clock, at which hour we were ordered to halt for breakfast.

The "Buffs" and Naval Brigade had just "piled arms," and the gunners were on the point of "unhooking," when we were startled by the rattle of musketry in the bush about 50 yds. to our front, where our native scouts had been posted. We lost no time in taking up position on a knoll which lay to our left, from the top of which we could overlook the bush in our rear and right and left, but which was commanded by hills in front; from this point we saw the Zulus swarming down our right flank, in what appeared to me to resemble *échelon* of companies. The infantry and Jack Tars swarmed up the sides with all speed, and, with the assistance of some of the latter men, the guns soon gained the summit, so that in a few minutes

from the time the first shot was heard we were firing shrapnel into a cloud of Zulus.

The tactics of the enemy were now apparent; they evidently intended to engage us in front, while large numbers swept round our flanks. However, the plan of attack, fortunately for us, was ill-timed, for the movement round our right flank was executed with marvellous rapidity, but that round our left we were happily enabled to check by sending round some mounted men and natives before it had fully developed itself. For the first hour the Zulus fought most stubbornly; having taken to the bush they directed most of their fire on our force on the knoll, and although we plied them with shell, rockets, and Martini bullets, yet it was fully an hour-and-a-half before they commenced to retreat from the bush on our right flank.

The 2nd division of the column, which had extended itself from the bottom of the knoll down the line of wagons, now brought its right shoulder forward and skirmished prettily through the bush. Having cleared the enemy from this part we were enabled to bring the fire of both guns to bear on the hill in front, to which the enemy still clung. It was now suggested to Colonel Pearson by Commander Campbell of the "Active," that it would be advisable to drive them from the heights. The Naval Brigade and a company of the "Buffs" were ordered to carry out the operation under cover of the guns. The Jack Tars seemed mad for blood, for they charged up the hill in any formation, banging away right and left, driving the Zulus before them. The company of the "Buffs" did their best to keep up with the sailors, but were not equal to the occasion, as they had been "doubled" up from the rear in order to take part in the attack. One of the Zulu prisoners taken in this action informed me that they considered they were getting the best of the action until "*those horrible men in white trowsers rushed up and showered lead on them.*" These were, of course, the Tar's in their ducks. The enemy now fled precipitately, throwing away their shields and assegais. The ground was strewn with dead bodies, some lying in heaps where shells had burst among them. The Zulu loss was estimated at 600 killed and wounded, while 7000 attacked us; on our side 13 killed and 17 wounded, while Col. Pearson and Col. Parnell of the "Buffs" both had their chargers shot under them.

Such, in brief, was the action of the Inyezane, and without further comment I may say we were thankful for having come out of it as we did. The artillery fired 65 rounds of shell; at the commencement of the action the practice with the shrapnel was excellent, but the want of a more perfect time fuze was sorely felt. Some splendid chances were lost through loss of time in boring and fixing. It is impossible to suppose that in the heat of action a time fuze can be bored with any degree of accuracy. A man may be possessed of great nerve, yet I defy him to have a perfectly steady hand on such occasions. Undoubtedly, one's first impulse is to discard the time fuze in action and use the percussion fuze altogether. When the enemy took to the bush the common shell and percussion fuze acted extremely

well—we did not notice a single case of "blind" shell, although 40 rounds of this nature were fired. The rockets, as I expected, proved of little value; so much had been said of their moral effect on savages, but, to my mind, the Zulus displayed the utmost contempt for them. The enormous 24-pr. Hale's war rocket fired from tubes by the Naval Brigade seemed to cause as much anxiety to our own men as to the enemy.

The column now pursued its route with delay, and bivouacked for the night on a ridge about three miles from the battle field. We started again at daybreak on the following morning and arrived at Ekowe mission station about noon.

This Norwegian mission station is built on a high range of hills overlooking the sea; in the distance were large rugged mountains, over which lay our path to Ulundi. The station itself consisted of a small church, the parsonage, school, and a few out-houses, built of brick with thatched roofs, all being hidden away among plantations, orange groves and gum trees—it was a most picturesque spot. The approach to the station was across fairly level meadow-land, with clumps of magnificent trees and patches of bush here and there; while close to the church was a lovely little bubbling stream shaded by forest trees. It seemed such a pity to destroy a beautiful, peaceful-looking little spot of this sort. The site was well adapted for a mission station, but was by no means a position on which to build a fort. It was commanded on three sides by rising ground within rifle range, while on the fourth side a ravine covered with bush ran up within a few yards of it; but, of course, the church and out-houses were invaluable as a hospital and storehouses, so that this site was chosen in preference to others which were better suited for defence.

Our orders were to form an advanced depôt at Ekowe, to construct a fort there, and, having completed our work, to move forward on Ulundi, leaving a sufficient garrison behind us. We were naturally in high spirits; our column had so far progressed admirably. We had encountered and defeated the enemy, and were fully convinced that with good honest work we ought to be on our way to Ulundi within two weeks' time.

Having, therefore, pitched our camp round the mission station, with the parsonage as Head-Quarters, we commenced to clear away everything which could afford cover to an enemy; the magnificent trees gradually disappeared, the gardens and orange groves were cut away, and out-houses, too far distant for use, were blown up. When this clearance was completed, ground was broken and the fort itself commenced.

It was now 28th January, but such a miserable system of inter-communication between the different columns existed, that at this date we were in total ignorance of the disastrous battle of Isandhlwana, which had been fought on the same day and at the same hour as the action of the Inyezane—so much so, that we actually sent down our empty

wagons (50 in number) to the Tugela, to bring up supplies, under escort of two companies of infantry! Easily then can an idea be formed of the sensation in camp caused by the arrival of the following despatch:—"From Lord Chelmsford to Colonel Pearson—Consider all my orders cancelled, you may expect the whole Zulu army down on you; do, therefore, what you may think best for the safety of your column." As may be supposed, the news came like a thunder-bolt among us; it was, however, no time for arguing or conjecturing; a meeting of commanding officers was at once summoned. The momentous question now put to us was, whether to retire at once to the Tugela or to hold our position against overwhelming odds for an indefinite period? This question was certainly a difficult one to decide. On the one hand by retiring we should lose the ground already gained; we should, moreover, have not a single column left in Zulu territory, since the others must, as we knew, be forced to retire; in addition, the mere fact of our beating such a hasty retreat on all sides would have a most disastrous effect on the minds of the Natal Kaffirs. These Kaffirs would otherwise say (Lord Chelmsford afterwards informed us they *did* say) "Oh! no, the English are not yet beaten; why, there is still a column in the heart of Zululand." On the other hand, by holding our position we overcame these difficulties and, moreover, held a check on the Zulus should they contemplate an invasion of British territory, for they could scarcely attempt such an enterprise with such a large force in their rear. An argument more forcible than these was, that a convoy of two months' provisions was within seven miles of our camp at that very moment. It was decided, then, to hold the fort at all hazards.

The mounted men, together with the two battalions of native contingent, were ordered to retire at once, as we had not sufficient corn for the horses of the former, and no room for the latter in the fort. We kept merely a sufficient number of mounted men and natives for vedette duty.

Our cavalry ought, no doubt, to have been kept at any risk; even if corn failed, there was an abundance of grass in the vicinity of the fort. We felt their loss greatly—we were able to gain literally no information of the movements of the enemy without them. Major Barrow, who was in command of them, was ordered to tell Colonel Ely, the officer in charge of the convoy, to hasten on with all speed, and to leave any wagon behind which could not keep pace with him. On that evening, to our delight, the convoy made its appearance, but it had been found necessary to abandon eight wagons, containing flour, biscuit, lime juice, coffee, and sugar—how we grudged their loss afterwards!

On the following day all the troops came inside the entrenchments, for as yet it had not assumed the dimensions of a fort. Tents were discarded, and the officers and men slept under wagons, which had been placed inside, round the parapet.

Now the defence of Ekowe commenced in reality. The garrison was as follows:—

Combatants.

Staff	7
The "Buffs" (6 companies)	609
99th Regt. (4 ")	380
Naval Brigade	174
Royal Artillery	26
Royal Engineers	96
Natal Pioneers	50
Native Contingent	15

Non-Combatants.

Commissariat and Transport	12
Army Medical Dept.	20
Conductors	15
Wagon leaders and drivers	270
Native servants	20

Total, 1339 whites, 355 blacks.

Armament.

1 gatling, with 127,000 rounds.
2 rocket tubes, 83 rockets.
1 " trough, 25 "
4 7-pr. M.L.R. guns, 150 rounds per gun.

For the next few days every available man was at work on the entrenchments, while the country round was cleared as much as possible, and although clusters of Zulus might be observed watching our movements, yet we were not interfered with. Occasionally we fired a shell at them, but as soon as they saw the smoke from the gun they would either lie flat down, or, bending themselves nearly double, would run like madmen.

In the space of a week we made our position practically safe; the ditch and parapet were now a respectable size, and it was merely a matter of improving and strengthening our work by degrees. The fort was in shape an oblong, the north and south sides being 120 and 180 yds. respectively, the east and west sides 300 yds. each. The ditch was 12 ft. wide and 7 ft. deep. The church was used as a hospital, while the schoolroom and parsonage acted as storehouses, and as I said before, the officers and men made shelters for themselves under the wagons, and by allowing the tarpaulin (with which every wagon is supplied) to fall over the sides, they managed to make themselves fairly comfortable.

It took some time before one became accustomed to sleeping under these wagons without doing daily damage to one's head, for on the command going round at night to "stand to your arms" (which took place when the alarm was given) one naturally jumped up imagining oneself in a tent, but the real situation was promptly suggested to one by a violent contact of head and wagon. After some time, when I got accustomed to my quarters, I found myself *rolling* out from under the

wagon on the alarm being given, having been taught on several occasions the folly of *jumping* up.

I can safely say that for the first fortnight of our imprisonment at Ekowe there was a scare every night, during the rest of our stay there they occurred at intervals. As a rule the cry was false alarm. One night for instance I remember hearing a rifle shot, followed quickly by two or three more; in an instant the gunners were at their posts on the guns and the infantry lining the parapet, for we all slept in our clothes. These shots were quickly followed by a rattle of musketry along one face of the fort; so sure were we (the gunners) that the Zulus had made an attack that we produced the case shot. However, in a few seconds the firing ceased, and the cause of the alarm inquired into. The answer was, "Please sir the sentry distinctly saw a Zulu loitering about round that bush outside." The real cause of the scare being a pair of sailor's ducks which were hanging up to dry on a bush, having been blown about by the wind. Next morning we discovered those articles riddled with bullet holes, which at least spoke well for the shooting!

Reveillé sounded at daybreak, and we then commenced to work at the entrenchments, while "last post" sounded at 8 p.m., at which hour lights were at once extinguished. Our rations at first consisted of flour, biscuit, tea, sugar, and meat. The two excellent officers of the "Buffs" (my messmates) and I divided our rations as follows. At breakfast toasted biscuit and tea, at mid-day meal the same, and at dinner our meat and anything our soldier-cook could make out of the flour. At first his cakes were most indigestible, as we had no baking powder, but he improved as time went on. Occasionally, when our troops made a raid on the Zulu mealie fields, a large supply was brought into camp, we then had an *entrée* of roast mealies, while we made the green tops into an excellent vegetable.

The 2000 head of cattle in our charge were a source of great trouble and inconvenience. During the day they were driven to the grazing ground under escort of two companies of infantry, while at dusk they were drawn in close round and under fire of the fort. A large number were placed in a wagon laager, the sides of which were enfiladed from the parapet, and the remainder tied down to their yokes. The horses and the mules were at first picketed outside, but as we soon became aware of their immense value we constructed a stable in the ditch, and had them driven there at night, by means of a ramp cut in the counter scarp. The stench at night then may be easier imagined than described, thus surrounded by cattle on the outside, and packed like herrings within. But in the daytime the men were encouraged to keep outside the fort as much as possible in their leisure hours, while the blacks were positively forbidden to enter the fort till nightfall, and were driven out at daybreak; our sanitary arrangements being exceedingly well managed, and the greatest attention was given to them by all hands.

As regards ammunition there was a plentiful supply so we now felt per-

fectly secure. Every means of procuring cover had been taken; traverses were constructed at intervals along the parapet, the guns placed on platforms, and protected by blinded batteries. As the weary days wore on, *trous-de-loups*, wire entanglements, caponiers in the ditch, and finally a drawbridge made their appearance. What we felt sorely was the want of medicine. We searched through the kits of the mounted men who had retired with Major Barrow and discovered a fair supply of "Eno's fruit salt," and "Cockle's pills," also some private stores, which were afterwards sold by auction. It may be interesting to mention that some of these articles fetched the following prices:—Bottle of pickles, 25s.; curry powder, 23s.; Worcester sauce, 25s. (per bottle); tin of lobster, 18s.; box of sardines, 12s.; and a ham, £7 10s.! Tobacco fetched 20s. per lb.

I recollect talking to a group of officers in the fort some few days after this sale about the reported surrender of *Oham*, brother of King Cetewayo. We were standing outside the wagon of the officer who had purchased the ham for £7 10s. He was amongst us in a moment, and said "What is that about another *ham*? Quite ready to give another £7 10s." He was ever afterwards called "Old Ham!"

Although there was a fair supply of gun ammunition, yet we discovered that the quantity of case shot was not sufficient, as this projectile would be most necessary in case of attack. Fortunately the idea struck me that one of *Morton's jam pots* might be made into a projectile of this description. It *exactly* fitted the bore. This important intelligence was conveyed to General Pearson, who issued orders for all the jam tins in camp to be left at the residence (under a wagon) of the O.C.R.A. Needless to say, the order was readily complied with, for I discovered the outside of my "chateau" littered with every conceivable description of tin, from those which contained butter (in shape like a forage cap) to the most diminutive potted meat tin. Having selected those required, we constructed, with the assistance of a tin-smith of the "Buffs," 25 excellent rounds of case shot. One of these articles may be seen in the R.A. Institution. We tested three rounds against dummies, and found they acted admirably.

On 7th February we received in a despatch an account of the disaster at Isandhlwana, which cast a gloom over the fort, for among the names down as killed we found many old and valued friends—many of them our companions in arms in the late Kaffir war. In this despatch Lord Chelmsford said: "Should like to see Naval Brigade garrisoning forts of Lower Tugela; you and your staff should be there also. Endeavour to arrange for the holding of an entrenchment requiring a smaller garrison. Your best field officers should remain in command. Bring back only what baggage is absolutely necessary—sick and wounded in empty wagons." At a council of war at once summoned it was unanimously agreed that it would be impossible to carry out Lord Chelmsford's wishes. In the first place we knew that a force of about 15,000 Zulus lay between us and the Tugela. How then could half our garrison, encumbered with wagons and with sick and wounded, hope to cope with such numbers. Again, we could not attempt to break

through under cover of night, as we could not by any possibility cover the distance (32 miles) in the time. Moreover, we could not carry out Lord Chelmsford's plan of "arranging to hold an entrenchment requiring a smaller garrison." For, should half our garrison be sent away, the remainder would be insufficient to man the parapet of our fort in case of attack.

To this despatch, Colonel Pearson therefore replied, that these reasons in support of his remaining where he was were so strong, that he determined to communicate them to him (Lord Chelmsford) before taking further action in the matter; and that he hoped Lord Chelmsford would reconsider the words of his despatch.

We waited anxiously for a reply from Lord Chelmsford, but the "runner" who took this despatch shared the fate of many others; so our garrison remained at Ekowe.

Some of the Kaffirs, composing our Native Contingent in the fort, would volunteer to run through the Zulus at night for a sovereign! Many were the letters I sent home, but I have since discovered that only three arrived safely, so conclude our poor "runners" seldom escaped the vigilance of the enemy.

We had now been 20 days shut up; the monotony of the situation was becoming dreadful; we were of course unable to walk or ride out of sight of the fort, so we found difficulty in passing the time.

The impertinence of the Zulus was becoming laughable. They would shout out "come out of that hole you old women; we always thought the English would fight, and not burrow under the ground!" Having in the meantime looted the wagons of the convoy abandoned by Colonel Ely, they frequently informed us that our coffee and sugar, &c., was excellent, and that they hoped soon to come and share ours with us!

This war of words was carried on between our cattle boys and the Zulus posted on the neighbouring hills.

On the 22nd February the enemy made a faint-hearted attack on our cattle, but were repulsed with loss by two companies of infantry, and the mounted men. Beyond this attack, and few successful raids made by our troops on their mealie fields, nothing important occurred until 1st March.

We intended on that day to make a sortie against Dabulamanzi's military kraal, which was situated about eight miles from the fort, and from which parties of Zulus frequently appeared for the purpose of harassing our cattle guard. Our plan of operation was to start about midnight, or a little after, and to arrive at the kraal if possible about daybreak. It was, however, 2 p.m. before all arrangements were complete, and our force started off. It was composed of the following troops:—400 infantry, some native pioneers, about 30 mounted men, and one gun R.A. The night was luckily clear, for we struck a path straight across country, under the guidance of one of our Zulu allies.

It was the most silent march I ever took part in, and will be long

remembered. All orders were given in whispers, we seemed to glide along, and yet the gun-wheels creaked outrageously, or rather one seemed to imagine so.

Our progress was not rapid, as halts were called continually in order either to overcome obstacles, or to allow our guide to inspect the country. When within half-a-mile of the kraal the day began to break, and here an incident worthy of mention happened. About 500 yds., on a hill to our left, I noticed in the dim light some kraals, and perceived a Zulu strolling leisurely out of one of them. For a few seconds he had his back to us, but quickly turning round no doubt espied our little force wending its way along below. He fled like a hare. The circumstance was at once reported to Col. Pearson, who sent four mounted men to try and cut him off. It was, however, too late, and I feel sure that the man upset our plans, for on arriving in sight of the military kraal some few minutes after, we saw to our disgust the whole Zulu "*impi*" streaming out of it with all their goods and chattels in their arms. We could hear the loud voice of the chief giving orders, and the cattle being driven away. We were unfortunately unable to bring our gun into action on them as they moved down a hill out of sight, but we sent our mounted men forward to take and burn the kraal. They found it evacuated. The rest of our force moved forward as rapidly as possible, and soon came in sight of the retreating Zulus, who were already some 1500 yds. distant, streaming up a hill opposite. We fired two or three rounds of shrapnel at them, killing and wounding about ten, but owing to the thick cover the fire was not very effective. The Zulus soon crowned the hill opposite, which overlooked the private kraal of Dabulamanzi, but Col. Pearson considered we should lose too many men in attempting to burn it, so we had to content ourselves with having destroyed the military kraal. We therefore retired ignominiously. Dabulamanzi afterwards informed me that the Zulus considered that we had received a decided reverse in this little expedition. They showed us indeed at the time that they thought so, for our retreat was closely followed. They appeared on the crests of hills soon after we vacated them; took advantage of every patch of bush to our right and left by keeping up a hot fire on us. We divided our mounted men into a front and rear guard, and thus kept the enemy from closing in on us, but were forced to halt at intervals and silence them with a volley.

It was really a pleasure to watch the manner in which these Zulus skirmished. No crowding, no delay, as soon as they were driven from one cover they would hasten rapidly to the next awkward bit of country through which our column would have to pass. Luckily for us their shooting was inferior, or we should have suffered severely. We arrived safely at the fort about midday. So ended the exciting but most unsatisfactory expedition to Dabulamanzi's kraal.

It was on 2nd March that one of our vedettes reported that glasses were being flashed from the Lower Tugela. Sure enough, there was flashing going on as distinctly as possible. Our signallers were at once summoned, and were not long in reading the following message:—

"Look out for 1000 men on 13th; be prepared to sally out when you are aware of my presence." This message was repeated for the next two or three days, as we were unable to convey to them that we understood. However, by 5th March we had fixed our glass sufficiently well to inform them we had taken in the message, and they commenced to forward further information.

I cannot tell you how delighted we were on the receipt of this news. The spirits of the whole of the troops seemed to improve, even the poor sick men in hospital—some on the point of death—seemed to be cheered up with the happy intelligence. For some days the weather was cloudy, so signalling was impossible. Nothing worthy of mention occurred in the meantime except that a runner made his appearance in camp, bearing a despatch a fortnight old; this aroused our suspicions, more especially when we noticed that he wore an overcoat with the badge of 24th Regt. on it. Our Kaffirs, moreover, informed us that he could not have come from the Tugela by any possibility, as he was "oiled" and his legs bore no marks of having been in the bush. In fact, he was no other than a Zulu spy. He was at once put in irons, and remained so till we were relieved. What became of the wretched man, I know not. When with us he was continually informed that his ultimate fate would be the gallows.

Just at this time one of our vedettes was killed and another wounded by Zulus, who surprised them by creeping up through the long grass which surrounded their posts. The latter vedette escaped miraculously; while sitting on his horse, evidently half asleep, with his carbine *slung across* his shoulder (contrary to orders), he was suddenly surprised by about a dozen Zulus. By his own account they rushed in on him, one of them actually laying hold of his horse's bridle. By dint of spur he cleared himself. The Zulus then fired a volley at him, but to his delight his horse went on, although he felt himself wounded. This man arrived safely in camp, although he had been shot through both thighs, two fingers shot off (or had to be cut off from effects of the wound), and his horse assegaied. We found, in addition, a bullet hole in the pommel of his saddle, and the splash where a bullet had hit the lock of his carbine. Curiously enough, this very man was afterwards brought before my brother, a resident magistrate in Ireland, for having assaulted an old man and stolen his hat, for which joke the Ekowe hero, I am sorry to say, payed the penalty.

We had now thoroughly established communication with the Tugela by means of our primitive heliograph, which in reality was nothing more than an eighteen-penny bedroom looking glass, which can be seen at any time in the United Service Institution. By degrees we became acquainted with the events of the past two months, of which we had hitherto been in total ignorance. As each message was flashed, the excitement was intense; the men crowding round and straining their ears to hear each letter as the signallers pronounced it. As each word was spelt it was communicated to the crowd, whose pleasure it was to anticipate the meaning of the whole message. I recollect, on one

occasion, sitting next to General Pearson when the following message was spelt out:—"Mrs. Pearson is —" then a dead silence all round; the sun had gone in and, as yet, we were unable to tell what the next word would be; would it be dead, or alive, or what? I shall never forget my general's face when the sun having again shone out we read the letter "W," and he at once knew the word would be "Well." His look was that of intense relief.

At the end of each day the "Latest Telegrams" were posted on a board in the fort, and eagerly devoured by the men.

As we now fully expected relief on 13th March, we made every effort to repair the road for the advance of the relieving column. This operation was carried out under considerable difficulty, for so sure as the troops were marched down to their work, so certain were the Zulus to collect from the neighbouring kraals and open fire on them. We were obliged to take out the guns and an escort every morning to cover the road party. As a rule the Zulus opened their fire from long ranges and did no damage; however, they succeeded in wounding poor Lewis, of the "Buffs," very badly in the head; he was directing the men of his company, which was posted just below the guns, when I saw him fall, he was instantly picked up by two of his men; on arriving on the spot, I saw his face covered with blood and found that the bullet had passed through the peak of his helmet and hit his forehead just above the eye—a very lucky escape.

We were now receiving three-fourths our proper rations of everything except meat. We had killed all the "fatted" oxen and were living on the "*trek*" or draft bullocks. Hard was no name for the meat; it was simply impossible to get one's teeth through it unless it was stewed down to ribbons. However, we were quite happy as we hoped to see the relief column on 13th.

Our utter dismay and disappointment may then be easily imagined when we received the following flash-signal on 12th March:—"The relief column will not march till the end of the month, as Lord Chelmsford considers it advisable to await the arrival of reinforcements."

Our hopes, buoyed up for the past 10 days, were now dashed to the ground; we were to return to monotony and imprisonment. It was heart-breaking to be forced to impart this news to the sick, some of whom had, seemingly, taken a new lease of life at the idea of relief being so close at hand. Poor Captain Williams of the "Buffs" died on this very evening, and young Coker of the "Active," the midshipman who was so popular amongst us all, died of dysentry. He was a fine young fellow, beloved by his men, and only eighteen years' old. His burial was the most affecting sight I ever witnessed in my short life; there were very few dry eyes. Out of our small force there were 150 men in the hospital, where there was overcrowding and a deficiency of medicine; the doctors worked manfully, and did all in their power to alleviate the suffering of their patients. The majority of the sick suffered from fever, which in most cases turned to delirium. The moaning of these poor men throughout the night was painful to hear, especially as one was certain to be informed in the morning that another death had occurred.

On the 11th and 12th of March we had observed from our "look-out" hill large numbers of Zulus "*trekking*" towards the Tugela, evidently sent to oppose the relief column. So good was their "Intelligence Department," that they discovered the relief had been temporarily postponed, and on the 14th we saw the "*impi*" marching back. We estimated this force at 35,000 men, so that had the relief marched up as originally intended they would have fared badly.

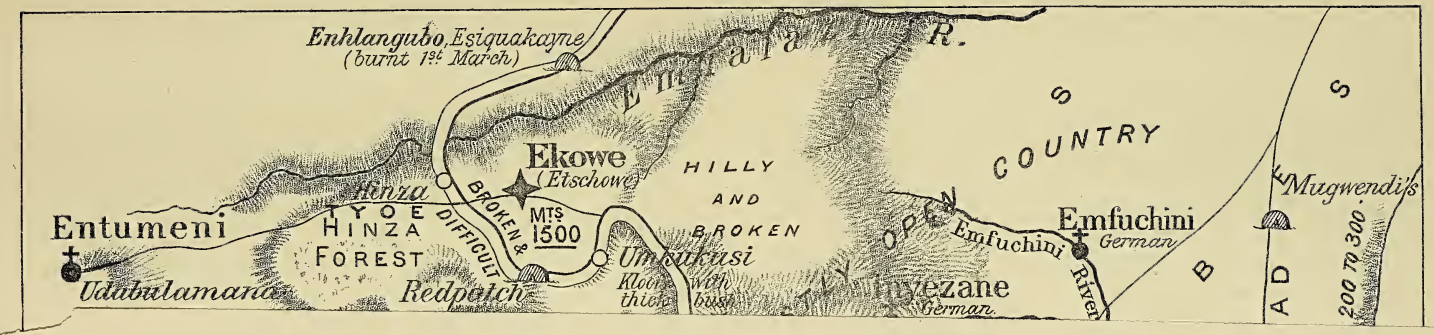
Three days and nights of rain now followed; it came down in torrents. The fort presented a miserable appearance. The mud in some places being about six inches deep, and everything and everybody soaked through and through! The poor sentries and vedettes suffered greatly, the remainder of the troops huddled together under the wagons and endeavoured to keep dry. It was indeed a wretched spectacle. Nothing to do, nothing to amuse ourselves with, not a book, paper, or game of any sort.

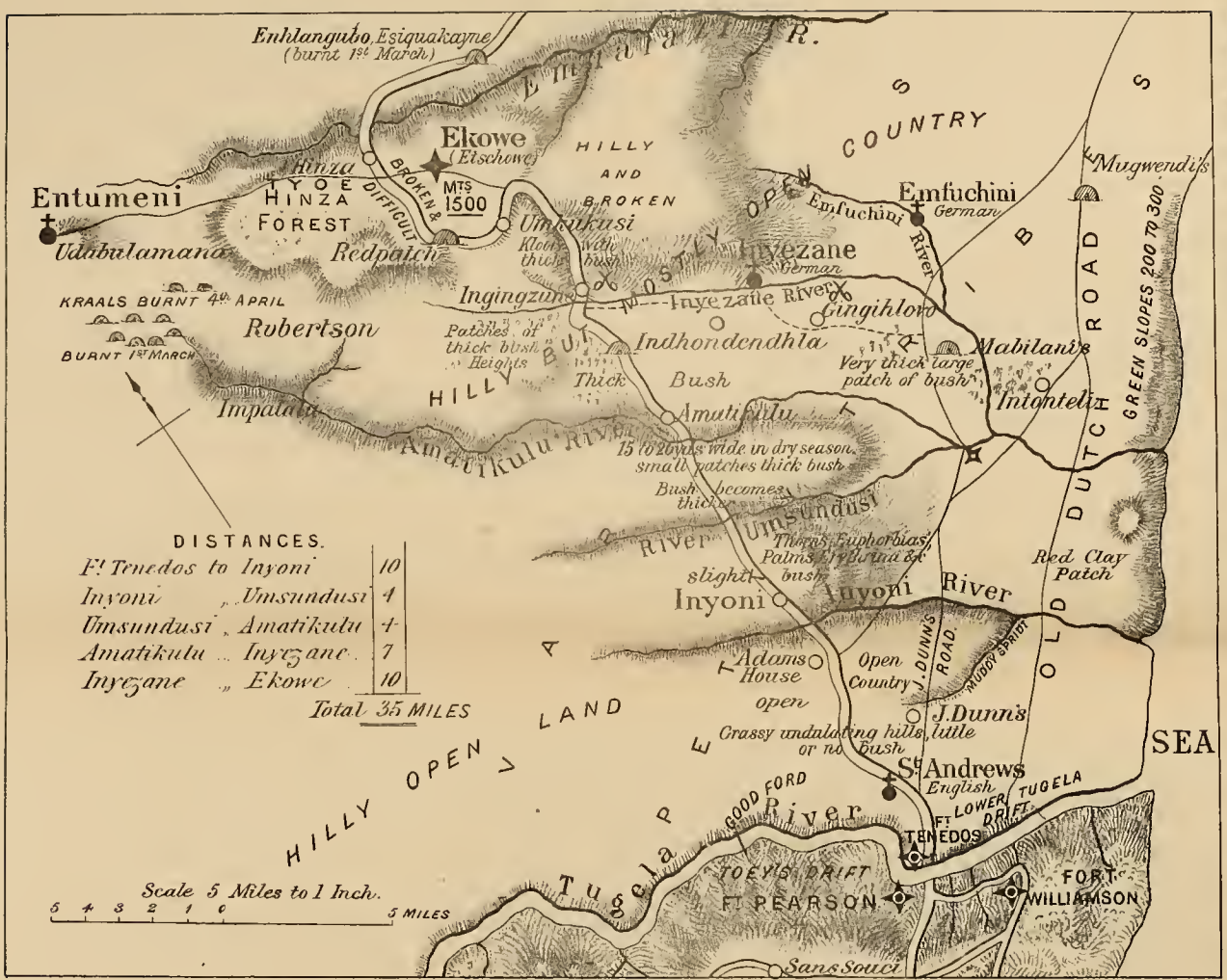
People at home seemed to imagine that it was principally on account of the scarcity of provisions that our existence was rendered so unbearable. But to our minds the monotony of the situation had a far more dispiriting effect than the small quantity and badness of the food. We were unable to take much exercise, our appetites therefore were poor. So long as the men had work on hand—in fact during the time the fort was being constructed—when all hands were engaged, their spirits were good and little sickness prevailed. But when work ceased, monotony set in, and there was time on hand to brood over the situation; then I noticed the sick roll increased alarmingly.

On 20th March a "runner" arrived in camp from the Tugela. He received quite an ovation, as he was the first "runner" who had reached us in safety for 38 days. In the despatch brought by him we learnt that the relief column would march on 29th, and eagerly we looked forward to that day.

On 23rd, two Zulus made their appearance, bearing a flag of truce. They asserted that they had been despatched by King Cetewayo to inform us that he would give us permission to retire to the Tugela unmolested, provided we did no harm to his crops or kraals. He, moreover, invited us to send officers to treat with his "*indunas*" or chiefs on the other side of the Umlalazi River, and guaranteed that not a hand should touch them. We were not blind to the fact that these men were simply spies, and our ideas were confirmed on the receipt of a flash-signal received that very day to the effect that Cetewayo was doing his utmost to draw us out with the intention of annihilating the whole force. These two wily Zulus were also placed in irons.

On the following day we received a message from Lady Frere, saying "Her best wishes to all; we were constantly in her thoughts, and all news of us she communicated to our friends." This kind message was highly appreciated. Another message was received on 29th, from Lord Chelmsford, as follows: "Come down with 500 fighting men when I am engaged. Four thousand men will leave the Tugela to-day or to-morrow, and arrive at Ekowe on 3rd April; expect to be hotly opposed." Colonel Pearson replied that he could not spare the 500


Enhlangubo, Esiquakayne
(burnt 1st March)
Ekowe
(Etschowe)
HILLY
AND
BROKEN
COUNTRY
Hinza
BROKEN &
DIFFICULT
TYOE
HINZA
FOREST
MTS
1500
Entumeni
Udubulamana
Redpeich
Umkukusi
Klooff thick with bush
OPEN
Emfuchini
German
Emfuchini
River
Inyezane
German
Mugwendi's
200 to 300
SKETCH OF RO



SKETCH OF ROAD FROM FORT TENEDOS TO EKOWE

Mackrow & Macdonald Lith.rs London.

men, for owing to the ravages of sickness we had only just sufficient men to hold the fort in case of attack.

There were now three large Zulu armies reported to be in the vicinity of Ekowe, and their instructions were to "eat up" the relieving column, and then to turn their attention to us.

We were most anxious for them to attack us. Had they dared to do so they would truly have fared badly; for our position, to a force without artillery, was very strong, and they would have come under a withering fire from the fort.

The cavalry scouts of the relief column were first seen on 31st March; they were evidently some miles ahead of the column, and about 13 miles from the fort. However, on the following day, with the aid of field glasses, we made out the white hoods on the wagons of Lord Chelmsford's Column. Towards evening we saw them halt and form laager.

But in the meantime Lord Chelmsford had informed us by flash-signal, that at daybreak on the day on which he intended to march into Ekowe he would fire two guns as a warning for us to be on the look out; and in case of his force getting the worst of an engagement with the enemy to be ready to render him any assistance in our power with such troops as could be spared. Accordingly the following troops were ordered to be under arms at daybreak on 1st April, ready to turn out at a moment's notice,—6 Companies of Infantry (350 men) some Naval Brigade and Royal Engineers (50 men) Mounted Infantry and one gun Royal Artillery.

The laager formed by Lord Chelmsford's column lay in the plain below the Ekowe heights, about 12 miles distant from the fort. The name of the spot was Gingilovo. The relief column had not advanced by the road originally selected by our column, but had used the coast (or John Dunn's) road in order to avoid the thick bush, through which they would otherwise have been obliged to pass. But by 31st March they had commenced to work gradually inland again, and the laager which they formed at Gingilovo on that day was within four miles of the Inyezane, the spot where our first battle was fought. We then made certain that the Zulus would allow Lord Chelmsford to break up his laager and advance until his force reached the Inyezane, and had commenced the ascent of the Ekowe hills. Here the bush was very thick, the ground uneven, and favourable to their method of fighting. At the same time we fancied that their attack would be delivered *as far from* Fort Ekowe as possible, consistent with their tactics, as they must be aware the danger of being suddenly taken in rear by our force.

There was not much sleep that night in Fort Ekowe. What with the hope of relief and the expectation of a fierce battle on the morrow, talking was kept up till a late hour. Of the events which took place next day, the 2nd April, I shall tell my own story:—

At the dawn of day I crawled out as usual from under my wagon. The niggers who, as I before said, were generally driven out at daybreak were still inside the fort, some slumbering peacefully, some few other restless creatures like myself had left their resting places, but

as yet there was little stir. I was looking over the parapet at the horses in the ditch below, when I heard quite distinctly the "boom" of a gun in the distance. I at once said to myself "the column is about to commence its march." I ran towards the middle of the fort to inform Colonel Pearson, but he was already astir; in fact, the whole camp was alive as if by magic. We listened for the second gun; the clear sounding "boom" again fell on our ears, but was quickly followed by a third report! The battle had commenced! It was no march! In no time we were running as hard as our legs could carry us to the nearest point whence we could see the laager in the plain below. This point was about 300 yards from the fort. On arriving there I saw the laager enveloped in smoke, and could distinctly hear a terrific rattle of musketry and the booming of guns, and could see the rockets flying in all directions. It was a lovely, still, clear morning with a slight mist at first rising from the plain, but this soon cleared off, and with the aid of glasses and telescopes we made out fairly well what was taking place. The Zulus seemed to have surrounded the laager and to have made a most desperate rush, for their fire was apparently close to the wagons. They were met by a perfect blaze of fire which checked them. The incessant roar of musketry went on for about twenty minutes, when the enemy appeared to be retreating slowly and the fire slackened.

We did not for a moment doubt what the result of the battle would be; but at the same time our excitement was intense as we felt that on the issue depended our safety, and should anything unforeseen occur whereby the Zulus would gain the day we knew that the only hope was to try and cut our way back to the Tugela, for at this time we had only three more days provisions left.

There was a deep sense of relief amongst us when we observed the Zulus commence to waver. Those looking through the telescopes informed the remainder of the different movements observed. "Now the cavalry are coming out from the laager," I heard. We knew that victory rested with us. Sure enough the mounted men had emerged from the square and were charging the enemy. The Zulus were now retreating precipitately, keeping up a dropping fire. In a few minutes firing ceased altogether, and this short but decisive battle was over, having lasted only 40 minutes. The Zulu loss in this engagement was 700 killed. They fought with the greatest determination, many dead bodies being discovered within 30 yards of the trenches, while four were found within a few yards of the muzzle of the Gatling gun. The loss on our side was comparatively small, two officers and six men killed, two officers and 30 men wounded. The Zulu force engaged in this spirited attack was estimated at 12,000 men, while the "relief column" was composed of 4,000 whites and 3,000 blacks.

We "flashed" congratulations to Lord Chelmsford on his success, and were in turn informed that three regiments of infantry would march to our relief next day, and that Fort Ekowe was to be abandoned altogether as the General considered that the coast road was preferable. This latter piece of news was as disagreeable to us as the former was pleasant. It was too annoying to think that all our work had been

done in vain, that we were to give up the splendid fort on which we had taken so much pains and time.

On the following day we were hard at work making preparations for our retreat.

At about 5 p.m. on this day the special correspondent of the *Standard* made his appearance. The first arrival at Ekowe! He was greatly pleased with his having outstripped the other correspondents, and chuckled to himself when he informed us that the *Times* had stuck in a bog, and the *Daily Telegraph* had met with some similar fate. However, we shook him warmly by the hand, and overwhelmed him with various questions; the first strange face we had seen for 72 days. It was late in the evening before the infantry appeared. The 91st Highlanders brought up the rear, and marched past the fort at midnight, their pipes playing the lively strains of "The Campbells are coming." The defenders of Ekowe manned the parapet, and greeted them with ringing cheers which were well responded to by the "relievers." Many were the greetings and congratulations exchanged next morning.

The relief column had marched up on the shortest possible rations. They therefore informed us that they had suffered much from the pangs of hunger, and felt they undoubtedly had come to the wrong place for assuaging their appetites. However, as luck would have it, much to their surprise, we managed to assist them, for we had carefully put aside three days full provisions, in case we should be forced at any time to cut our way back to British territory. These rations were produced, and our gallant "relievers" enjoyed a hearty meal after their exertions of the past five days.

But it was remarked that most of the newspaper correspondents reported that the garrison of Ekowe had suffered but little from the scarcity of food, that they found the place well stocked with provisions, one of them went so far as to say that he never enjoyed a better meal in his life than that supplied by the starved-out heroes of Ekowe. The real truth being that they were gloating over these three days provisions which we had treasured for so many days, and had longed to "be at" on so many occasions.

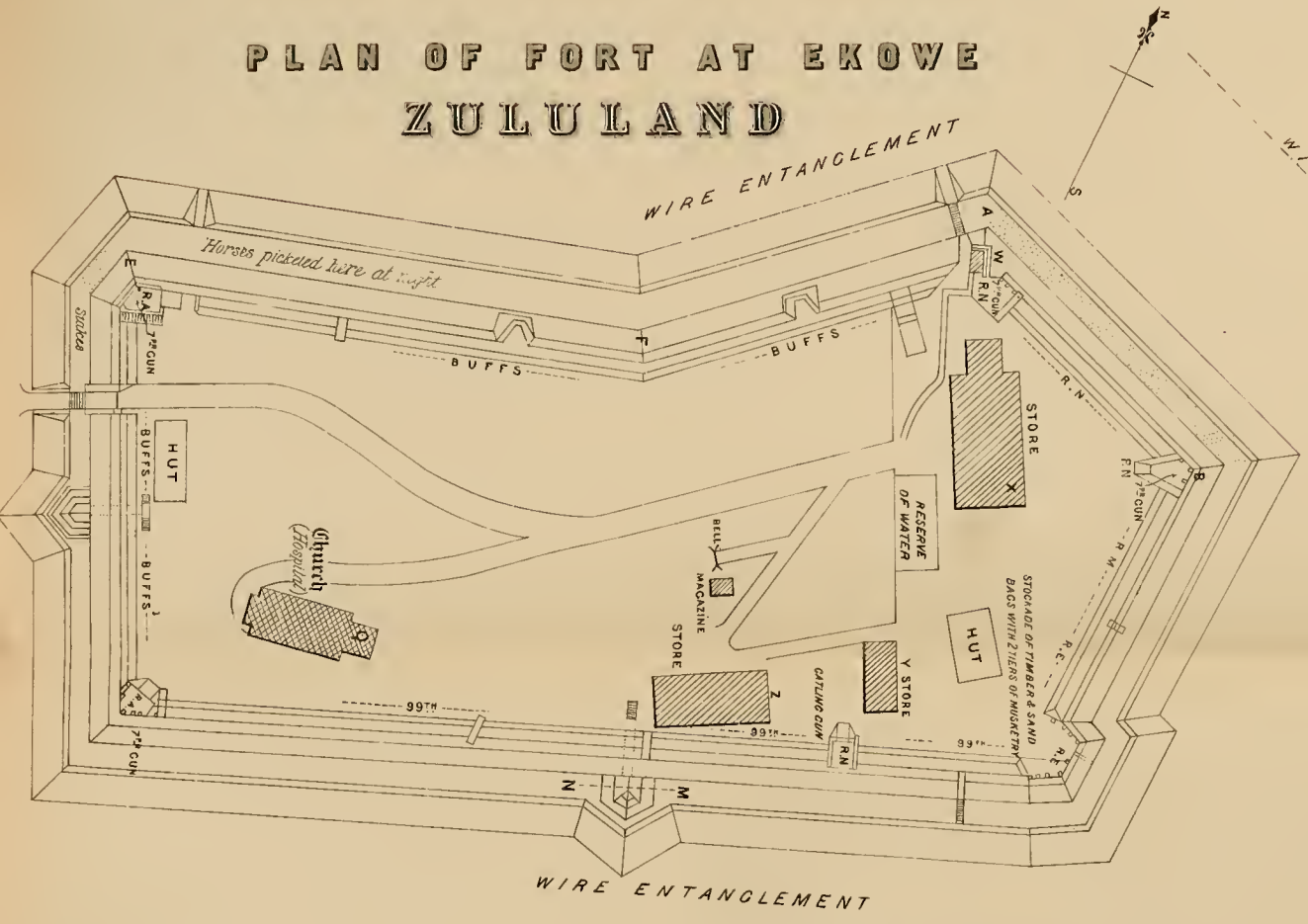
During the defence we buried six officers and 35 men; and took away with us about 120 sick, while Captain Wynne of the Engineers, and Thirkill of the 88th both died shortly after our arrival at the Tugela.

On the morning of 4th April, we commenced our retreat from Ekowe, accompanied by all our wagons, ambulances, &c., and covered by the force under Lord Chelmsford. The sense of being once more free was delightful; and our men, notwithstanding their long confinement, marched splendidly. We passed our old battle field at the Inyezane, skirted Gingilovo, and on 8th April reached the Tugela.

So terminated the first phase of the Zulu campaign as experienced by No. 1 Column. In a few days the Ekowe garrison, now distributed among the 1st Division, was on the march, once more ready to commence its battles o'er again.

PLAN OF FORT AT EKOWE
ZULULAND

PLAN OF FORT AT EKOWE
ZULULAND



Traced from plans drawn by Lieuts. Main & Willock, R.E.

ON IMPROVED SHAPE FOR MOULDING GUNPOWDER,

BY

LIEUT.-COL. M. TWEEDIE, R. A.

Of the various gunpowders manufactured for the use of modern heavy ordnance, that called the German prismatic has undoubtedly given the best results.

These good results have been attained mainly from its peculiar shape; an hexagonal prism with a hole through the centre, and to the nature of the surface given to the faces of the prisms.

The cartridge is built up of these hexagonal prisms, the holes through which will coincide, and form a passage for the flame to pass rapidly through, igniting the surface of the holes. Each prism of gunpowder will then burn from the interior to the exterior, on a constantly increasing surface, and thus making it, what is termed, a progressive gunpowder. The faces of the prisms are given a surface that will not rapidly ignite, and this, in conjunction with the size of the holes, limits the amount of gunpowder at first ignited, regulating the pressure.

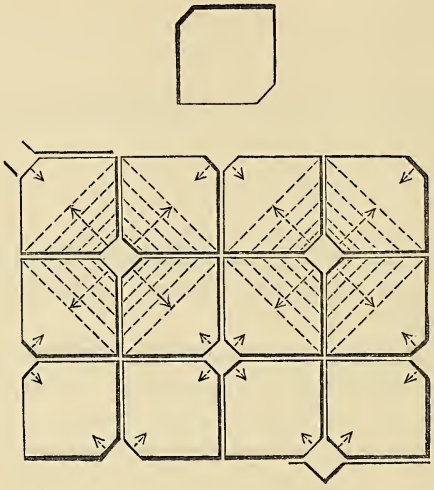
In theory, and also in practical results, this gunpowder is excellent, but it is open to the following objections :—

It is expensive, and neither easily nor safely manufactured. It can only be moulded in short prisms on account of having to make the hole through the centre. It has all to be bought from foreign manufacturers, as it has not yet been successfully made in this country.

It must be admitted by all, that the manufacture of gunpowder is now in a very crude state, as compared with what we may expect to see within the next few years. I presume that the fear of accident has contributed to its manufacture having been simply handed down traditionally, without deviation from established custom; however, I am not at present going to enter into this subject of gunpowder further than to suggest a different shape for prismatic gunpowder, with the view of overcoming, so far as possible, the objections to the German prismatic gunpowder above named.

The shape, I propose that this moulded gunpowder should be made is "a prism the section being a square with two opposite corners cut off."

Now, on reference to the section below, it will be at once seen that



these prisms when built up as shewn, will form passages for the flame, the size being regulated by the amount cut off the edges of the cube; and furthermore, that, like the German prismatic gunpowder, it will be a progressively burning one, inasmuch as the burning surface will be ever an increasing one.

For purposes of comparison, the question of the flame passing through the joints of the prisms igniting the surfaces all round may be eliminated, as it is common to both; while the requisite surface could be more easily given to the faces of the solid prism, than to that with a hole through the centre.

In conclusion, the solid prisms could be moulded of considerable length, and the building up of the cartridge greatly facilitated.

ADDENDUM TO THE DRILL REGULATIONS OF THE FOOT ARTILLERY.

BERLIN, 1880.

Section 1.

ESTABLISHMENT OF A BATTERY.

The Establishment of every Battery consisting of 4 or more pieces of ordnance of the same nature is as follows :—

1 battery commander ;
the divisional commanders ;
the service establishment of gunners ;

also a reserve of men for "look out" purposes, for the supply of ammunition, and to provide for the subsistence of the men.

The guns are numbered from right to left.

The battery is further divided into divisions of two guns, numbered from the right.

Section 2.

POSITION OF OFFICERS AND MEN.

The battery commander (an officer or competent n.c. officer) takes up a position, in action, whence he can observe the effect produced by his guns, and insure his word of command being heard.

The divisional commanders stand between the guns of their division, facing the parapet.

The detachments take post in the usual manner.

The man detailed for observing errors in direction stands close to the battery commander or in any position ordered by the latter where by aid of his instrument he can best see the object fired at.

The men attending to the ammunition go to the magazine.

Supernumeraries clear of the battery under cover.

Section 3.

SPECIAL DUTIES OF THE OFFICERS, &c.

The battery commander conducts the fire of the battery in accordance with the directions received by him ; he superintends the working of the guns and is responsible that the regulations connected therewith are strictly adhered to.

He decides the nature of fire, elevation, and deflection to be given, the length of fuze, the order and rapidity of fire, and gives the necessary orders as regards corrections from the observations made on the results of the fire.

The record of the practice is kept under his directions by men specially detailed for this duty.

The divisional commanders are responsible for the correct serving of the guns of their division, that the nature of fire ordered is carried out, and the necessary corrections made.

They repeat the word of command of the battery commander relative to the elevation, deflection, and length of fuze, to be given loud enough to enable him to judge that his orders have been understood.

They give the order to fire, except when salvos or independent firing is ordered.

They observe the result of the practice of the guns in their charge, and are responsible for the range reports of the same.

It is not necessary they should remain in the position before mentioned, viz.—between the guns, if required to superintend the laying, &c.

Reports from the Nos. 1 of guns are made through them to the commander of the battery.

The Nos. 1 of guns are responsible for the service being conducted according to order, and note on a board placed on the parapet the No. of rounds fired, elevation, length of fuze, &c. given.

They attend specially to the working of the brush apparatus, the obturation, the tubes and fuzes, &c.

They are not required to observe the effect of the rounds fired.

After the gun is fired, the word of command to "load" is given by them.

They regulate the position of the recoil wedges.

Section 4.

GENERAL DUTIES.

All orders relative to the service of single guns apply equally to guns in battery, the only difference being in the word of command, "Battery" being used instead of "Gun."

With a view to insuring uniformity in the service of guns in a battery, and the various corrections ordered by the battery commander being carried out, the men should be accustomed to listen to the commands of their divisional officer and No. 1 only, and to devote their whole attention to the service of their own particular guns.

In order that practical requirements in the service of the guns should be the first consideration, simultaneous movements in the loading, &c. of guns in the same battery is strictly forbidden. Working the guns in slow time, by word of command, is also forbidden.

Section 5.

RATE OF FIRE.

The fire carried out in a battery is distinguished by the following terms :—

1.—*Ordinary Fire.*

The divisional commanders give the word "Fire" to their guns in succession, making the requisite pause (as ordered by the battery commander) between each round.

2.—*Slow Fire.*

The battery commander names the gun which is to fire, the divisional officer repeating the word of command.

This nature of fire is mainly applicable to trial shot firing.

3.—*Rapid Fire.*

The guns are fired in succession from either flank as rapidly as possible. The order to fire being given by the divisional officers.

The battery commander can also limit this rate of firing to the guns actually loaded only.

4.—*Salvos.*

All the guns that are loaded are fired simultaneously by word of command of the battery commander.

5.—*Independent Fire.*

Each gun is fired when ready, by command of the No. 1.

This nature of fire is forbidden with blank cartridge.

On the completion of the first round from guns fired under the conditions given under the head of 1-3, the divisional commander of the last guns fired makes this known to the commander of the centre division, who passes the word on. In case of a miss fire from any gun, the divisional officer fires the gun next to it, and acquaints the battery commander of the fact. The gun that has missed fire is in this case fired when its turn comes round again.

Section 6.

PREPARATION FOR ACTION.

The battery commander before giving the word "prepare for action" notifies to the divisional commanders and Nos. 1, and to the look-out men, the target and point to be aimed at, as also whether an auxiliary mark is to be used for laying, and if the tangent scale, or the quadrant and hanging scales are to be used.

If an auxiliary mark is used the choice of the same is left to the Nos. 1 under control of their divisional commanders.

In firing at fixed targets, the line is roughly laid out (or lines if there is more than one target), by nailing down the "battens," the exact line being obtained by trial shots.

The apparatus used for observing the deviations of the shots must be accurately layed on the point aimed at.

The divisional commanders superintend the obtaining of the correct line of fire, and then have the embrasures laid out.

Section 7.

ACTION.

On the command "action" being given by the battery commander the detachments proceed as laid down in para. 8 and 9 of the Drill Regulations. As soon as the Nos. 1 have satisfied themselves that their guns are ready for action they report to the divisional commanders. The latter having rectified any deficiency, report to the battery commander.

Any irregularity occuring during exercise or practice is reported by the Nos. 1 through the divisional to the battery commander.

The look out men, when they are ready, report to the battery commander. Neither the battery commander nor divisional commanders draw their swords or side arms.

Section 8.

SERVICE OF THE GUNS.

When the battery is ready for action, the battery commander,* before taking up his position as mentioned in section 2, places himself where he can overlook the working of the guns, and gives the order "attention" and in case the guns are to be laid by quadrant and hanging scales, the further order "With Shell Load" "$4\frac{2}{16}°$." On the word of command "With Shell Load" the service of the guns is commenced without further commands (para. 16 of the drill regulations).

When firing is to commence the battery commander gives the word "From the right (left) flank slow fire one round;" or having ordered the requisite pause between each round "From the right (left) flank, Ordinary Fire."

If the laying is by tangent scale, the commands given are: "With Shell Load"; "No. 3 Gun of direction," "$2\frac{12}{16}°$ elevation" "2 left deflection" "Slow fire from the right."

---

* The Battery Commander should make a pause after giving the order regarding elevation, deflection, and length of fuze, to allow it to be repeated by the divisional commanders before the next order is given.

Section 9.

POSITION OF THE BATTERY COMMANDER.

During the trial shot firing, the battery commander should not leave the position laid down in para. 2, except under the most urgent circumstances; in the succeeding rounds, however, he should change his position occasionally to supervise the service of the guns generally.

The practice and look out reports are kept in the meanwhile to enable the battery commander to judge at any time of the shooting of particular guns.

If he should find it necessary to leave the battery at any time to supervise the look out men, the senior divisional commander takes command of the battery, but the battery commander keeps the regulation of the fire in his hands, and keeps up his communication with the battery for this purpose.

Section 10.

TRIAL ROUNDS WITH COMMON SHELL.

The trial rounds are always fired at the same point of the target aimed at.

When the laying is corrected from the results obtained from successive guns, the battery commander orders the necessary correction in elevation after each round.

This correction (on the order being repeated by the divisional commanders) is taken up by all the other guns.

The battery commander gives the order for the necessary correction in deflection to be given to the gun last fired (according to the error in direction ascertained by the look out man) for instance "No. 2 gun + 4."

The error in direction having been repeated by the divisional commanders, the No. 1 having made the necessary correction on the scales repeats the order sufficiently loud for the detachment to hear it, and note it.

Should there be no error in direction, or should the deviation be so slight as not to require correction according to the regulation practice, the battery commander does not order any correction unless after a series of rounds it should be found requisite.

If corrections are ordered successively from gun to gun, the battery commander in naming the change of elevation, gives the No. of the gun, for instance "No. 5 gun $11\frac{4}{16}^{\circ}$" on which the divisional commander concerned repeats the word, and the gun named keeps to this elevation until further orders.

Section 11.

TRIAL ROUNDS WITH SHRAPNEL.

In firing shrapnel, the length of fuze is given before the elevation is named. With this exception, the words of command are the same as for common shell.

The loading can be carried out either by battery or by divisions.

(A) *Loading by Battery.*

On the word of command—
"Battery with shrapnel load."
"At the Field Battery."
"$5\frac{3}{8}$ fuze" "$4\frac{6}{16}°$ elevation" "2 left deflection."

All the guns are loaded and laid.

Each gun is sponged out after firing, laid, and the fuze set, but the charge not rammed home. 2 and 4 stand ready with the charge near No. 1, the breech of the gun remains open.

When all the guns have been fired, the battery commander gives out the corrections to be made, (the order being repeated by divisional commanders) followed by the command "ram home" on which all guns are again loaded.

(B) *Loading by Divisions.*

The command is given—
"By divisions with shrapnel load."
"On the line of skirmishers on the edge of the wood."
"No. 1 division $5\frac{3}{8}$ fuze" "$4\frac{6}{16}°$ elevation."
"2 left deflection."

On the order being repeated by divisional commanders the Nos. 1 of the division named, give the order "load," those of the other two divisions "sponge out."

After the two guns of the named division have been fired (the 2nd gun having made the necessary correction in elevation) the battery commander gives out the length of fuze and elevation for the next division, for instance—

"No. 2 division $5\frac{4}{8}$ fuze" "$4\frac{8}{16}°$ elevation."

The divisional commander repeats the word as before. The Nos. 1 having seen to the length of fuze and elevation required, give the order to load and make ready.

The practice is continued with the remaining guns on the same principle.

If the battery commander considers no correction necessary, he gives the word "No. 2 division, ram home" whereupon the guns are loaded and made ready, the remaining divisions awaiting orders as before.

On the command "independent loading" each gun is reloaded after firing.

If necessary to make further corrections in the length of fuze, the division commander notifies his having done so (to the battery commander) before firing, by calling out "No. — gun length of fuze altered."

If the battery commander desires to correct the height of burst above plane he orders the requisite change in elevation to be made for any particular gun or division, without however repeating the length of fuze.

Section 12.

ALTERATION OF LINE AND DISTRIBUTION OF FIRE.

If a distribution of the fire of the battery should be found necessary after trial rounds at moving targets, or when firing shrapnel, or should it be desired to direct the fire on some other point of the original target, (for instance at another gun, &c.), it is imperative that the two guns of each division should fire at one and the same object.

In such cases, the battery commander orders a distribution of fire (by alteration of the tangent scale) as follows :—

"*Distribution of Fire.*"

"No. 1 division—Target as before."
" „ 2 „ On the 5th gun."

and notifies to the commander of No. 2 division the requisite alteration in deflection to make.

If the laying is by scales, the battery commander informs the look out men of the new distribution of fire ; they then watch the practice of the guns laid on the new target, and insure the line being correctly obtained.

Section 13.

ALTERATION IN RATE OF FIRE.

If necessary to change the rate of fire, the battery commander notifies the same as follows :—

"Ordinary Fire," "Slow Fire," "Rapid Fire," or "Salvo."

Divisional commanders carrying out the instructions given in Sec. 5.

Section 14.

PRACTICE WITH CASE SHOT.

The command given by the battery commander is as follows :—

"With case shot load."
"On the Infantry"—"400 metres."
"Independent firing."

The No. 1 orders the elevation necessary.

Section 15.

ALTERATION IN THE DESCRIPTION OF PROJECTILES USED.

The battery commander having given the word "Cease Firing," gives the next order without reference to the target aimed at, for instance as follows:—

a. "Change to Shrapnel."

The order "Cease Firing" having been given, is followed by "Battery with Shrapnel load," "$5\frac{3}{8}$ fuze" "4 $\frac{6}{16}$° elevation" "2 left deflection."

The guns already loaded are fired with the elevation before given.

The divisional commander of the gun first firing the new description of projectile, notifies the same to the battery commander by calling out 1st or 2nd gun "Shrapnel."

b. Change to case shot. "Cease firing."
"With case shot load." "300 metres."
"Independent firing."

The No. 1 gives the order "elevation over two fingers."

The guns already loaded are fired with the elevation ordered for case. In changing from case to shell fire, &c., the loaded guns are unloaded.

Section 16.

ALTERATION IN THE TARGET AIMED AT AND RANGE.

The battery commander having given the order "Cease Firing" notifies the description of fire, target to aim at, elevation, &c., and rate of fire. All guns whether loaded with case or shell, continue the practice at the point named, and with the new elevation ordered.

Guns loaded with shrapnel, are fired off rapidly with the elevation before given, and laid as in previous rounds.

Section 17.

CESSATION OF FIRE.

On the order by the battery commander, "Battery cease firing." "Return Stores," the instructions given in Sec. 17 of the Drill Regulations are followed.

If necessary to sponge out the order is given by the Nos. 1.

The latter report to the divisional commanders, and these to the battery commander, when the stores are returned and any deficiency relating to them.

PREFATORY NOTE.

The following paper was originally drawn up for private use. It does not claim to contain much original matter, but is a prècis of the Committee's report, and is, in a great measure, a verbatim copy of their recommendations, &c. As the report itself is somewhat bulky, and may not be within the reach of all, it is hoped that these notes may be found useful for the general reader.

NOTES

FROM

"REPORT ON EXPERIMENTS WITH ARMOUR-PIERCING PROJECTILES UP TO 9-IN. CALIBRE,"

Dated 22nd June, 1880.

BY

CAPT. J. P. CUNDILL.

Preliminary Experiments.

The experiments were divided into two series—

1st Series. To test material for armour-piercing projectiles.
2nd Series. To determine the best form and material for armour-piercing projectiles.

1st Series.

The object of the first series was to test the material of projectile only, and it was decided to use the 9-in. R.M.L. gun, with such a powder-charge as would give to a projectile weighing 268 lbs. a striking velocity of about 1500 ft. per second.

This, by the usual formula,

$$b = \left(\frac{Wv^2}{2gK \times 2\pi r \times 2240}\right)^{1\cdot6},$$

would give power to penetrate an unbacked wrought-iron plate 12·71 ins. thick.

One brand of P^2 was used (No. 112), with the exception of a few rounds fired with Brands Nos. 137 and 143, and the charges were at first

$$65P^2\left(\frac{27{\cdot}0}{1{\cdot}027}\right),*$$

and afterwards

$$75P^2\left(\frac{32{\cdot}25 \text{ to } 33}{{\cdot}847 \text{ to } {\cdot}840}\right).$$

The projectiles were studded and fitted with the Lyon gas-check in the R.L.,† and were all of the service form (9-in. Palliser shell, Mark IV.) They were all brought, by weighting with sand, to the required uniform weight of 268 lbs.

They were fired directly at a range of 50 yds.; afterwards, to avoid injury to the Le Boulengé chronograph screen, at a range of 92 yds., against unbacked wrought-iron plates hung on supports by means of trunnions. These plates were 12 ins. thick, and 4 ft. square; this size being found suitable to resist fracture on impact of shell. They were supplied by Sir J. Brown and Co., Atlas Works, Sheffield, and every care was taken to ensure uniformity of quality. Each plate cost rather more than £130.

The velocity of each round was observed.

The shells tried were of four classes—viz., chilled cast-iron, cast-steel, chilled cast-iron heads and cast-steel bodies, and forged steel.

The chilled cast-iron shells were obtained from the following sources:—

1. Service shells from store.
2. R.L. improved.
3. Shells made of Gregorini (Italian) iron in R.L.
4. Shells made by the Finspong Iron Company (Sweden).
5. " Mr. Grüson (Germany).
6. " Mr. Krupp (Germany).

The cast-steel shells were obtained from the following sources:—

1. Landore Siemen's Steel Company.
2. Terre-Noire Steel Company (France).
3. Messrs. Hadfield and Co. (Sheffield).

The shells with chilled cast-iron heads and cast-steel bodies were obtained from the following sources:—

1. Messrs. Vickers and Co.
2. Messrs. Cammell and Co.

---

* The numerator of the expression in brackets gives the number of cubic inches per pound occupied by the charge when in the chamber of the gun, the denominator gives the gravimetric density of the charge, which must not be confounded with the actual density of the powder.

† R.L. here and elsewhere in the paper stands for Royal Laboratory.

The forged steel shells were obtained from the following sources:—

1. Messrs. Firth and Co.
2. Messrs. Sir J. Whitworth and Co.

Thus there were in all thirteen different makes of shell to be tried. Six projectiles of each kind were ordered, and the prices ranged per shell from £1 4s. 9d. for the service pattern to £15 for those supplied by Firth.

One shell of each kind was broken in the R.L. in order that the fracture of the metal might be examined. They were broken under a steam hammer, with the exception of the Terre-Noire and Whitworth, which were too tough for this treatment, and had to be cut.

Of the chilled cast-iron shells, the "R.L. improved" gave decidedly the best results both as to depth of indent and amount of damage done at the rear of the plate. These shells were made of—

Gun-iron (*i.e.*, old cast-iron guns and shells) ... 83·0 p.c.
Atlas metal (cuttings from Bessemer steel)..... 17·0 p.c.

and were chilled like the service Palliser shells.*

The other shells did less work on the plates, and all broke up on impact with the exception of one Finspong shell, which was badly cracked and set up.

All three makes of cast-steel shell gave results decidedly inferior to those obtained with the "R.L. improved" shells.

The shells with cast-steel bodies and chilled-iron heads supplied by Messrs. Cammell and Co., gave better effects on the plates than any of the above. The only other shells of this type, those supplied by Messrs. Vickers and Co., were too soft in the temper of the body, and produced small results.

The Firth shells were soft in temper, and were decidedly inferior to the Whitworth shells. The latter gave excellent results. Some of them went clean through the target, and were so little altered that they were re-studded and fired a second and even a third time.

The results obtained up to this time showed that it was of no use to make further trial for the present of cast-steel shells.

---

* The first six shells only were made of this mixture. It is doubtful if they could be economically supplied in large quantities, or whether a sufficient supply of Bessemer scrap could always be obtained. These shells gave really no better results than those given by shells made of the usual material. The 60 shell supplied with different forms of head were made as follows:—

9-in. Palliser shell.	Gun-iron.	Cwmbran white.	Old shells.	Scrap.
		Per centages of		
1½ Diamr. head	25	25	—	50
1¾ "	25	15 + 5 p.c. of No. 4 Cwmbran.	10	45
2 "	25	15	15	45

"Scrap" is deadheads, runners, and risers, &c., of Palliser shell.

The best type of each of the other three classes was selected for the continuance of the experiments, viz. :—

Chilled cast-iron	R.L. improved.
Cast-steel bodies and chilled-iron heads	Messrs. Cammell & Co.
Forged steel	Sir J. Whitworth & Co.

At this stage 33 rounds had been fired, made up as follows :—

Whitworth	4	Vickers	2
Cammell	3	Krupp	2
Firth	1	Service	2
Terre-Noire	2	Improved R.L.	3
Hadfield	4	Gregorini	2
Grüson	3	Finspong	3
Landore	2		

After this 41 more rounds were fired, of which four were from the 6-in. Armstrong B.L. gun, at various targets: chiefly the 12-in. wrought-iron plates; steel-faced (*i.e.*, steel welded to wrought-iron) plates; and wrought-iron plates with air-spaces between, consisting of two 2-in. and one 8-in. plate.

The 6-in. B.L. gun was fired at 10, 12, and 13-in. wrought-iron plates.

The 41 rounds were thus made up—

Terre-Noire	3	Whitworth { 9-in. gun	10
Hadfield	1	Whitworth { 6-in. gun	2
Service	1	R.L. improved	3
Firth	3	Capped Palliser	2
Cammell	11	E.O.C. chilled, from 6-in. B.L. gun	2
Gregorini	3		

Of the Whitworth rounds three were with shell that had been previously fired and re-studded.

The "capped Palliser" were fired to try the effect of 9-in. service projectiles, fitted with a wrought-iron cap, against steel-faced armour. The cap fitted over the head of the projectile, and extended as far as the extractor holes, into which it was secured by screws. Above the tip of the projectile the cap was 2·25 ins. thick, and its point was truncated to a breadth of 2·5 ins.

The origin of the experiment was that on one occasion a service Palliser shot had been fired at a steel-faced plate with a piece of 2½-in. wrought-iron plate placed in front of it. It was then found that the effect of the steel as regards the breaking up of the head of the projectile was completely neutralised, and its resistance consequently diminished to even less than that of ordinary soft-iron armour.

Two rounds were fired at damaged plates (no others being available), but owing to the condition of the plates no decisive results were obtained.

At a later stage two more rounds were fired direct at the "Inflexible" 9-in. steel-faced plates, and one obliquely at a 12-in. steel-faced block.

It was found that the capped shell were in no way superior to the ordinary service pattern, and consequently the Committee did not recommend any further experiments in this direction. A Cammell shell was the only one that completely perforated a steel-faced plate. The shell broke up.

The Whitworth shells perforated the air-spaced targets, even when the front plates were placed obliquely to the line of fire, without being materially altered in form. The others broke up against the rear plate even when the front plate was perpendicular to the line of fire.

2nd Series.

The 2nd series, in which endeavours were made to determine the best form and material for armour-piercing projectiles, was carried on with studless shells fitted with rotating gas-checks.* It had been found that the studded shells, when they broke up against armour, invariably did so through the lines of weakness formed by the stud-holes, and satisfactory trials were made to establish the equal, if not superior, accuracy of the studless shells.

The experimental projectiles were as follows:—

R.L. Chilled Shells, weighted to 274 lbs. 8 ozs., and having heads struck with radii of 1·5, 2·0, 2·5, and 3·0 diameters.

Cammell's Shells, with cast steel body and chilled head, weighted to 274 lbs. 8 ozs., and having heads struck with radii of 1·5, and 2·0 diameters. Also two special patterns of head, one having a sharp pointed head made by curves of various radii, and the other resembling the first, but having the point truncated.

Whitworth Shells of forged steel, weighted to 247 lbs. 8 ozs., and having heads struck with radii of 1·5 and 2·0 diameters. Also one flat-headed shell weighing about 296 lbs.

These projectiles went through their competitive trial by being fired—

a. Directly against unbacked wrought-iron 14-in. plates.

b. Obliquely against unbacked wrought-iron 12-in. plates. The angle of the line of fire with the perpendicular to the force of the plate varied from 30° to 37° 4′.

c. Direct fire against unbacked steel-faced 12-in. plates composed of 4 ins. of steel welded to 8 ins. of wrought-iron.

d. Oblique fire against unbacked steel-faced 10-in. plates, composed of 4 ins. of steel welded to 6 ins. of wrought-iron. The angle of the line of fire with the perpendicular to the face of the plate varied from 25° to 27°.

Precautions were taken to ensure uniformity of quality of plates, and a uniform striking velocity.

---

* *i.e.*, gas-checks which impart rotation to the shell.

The result of *a* was as follows:—

Order of merit.	Maker.	Nature of shell.	Form of head.
1.	Cammell.....	Cast steel-chilled head ...	Special No. 1 (sharp point).
2.	Whitworth	Forged steel	Head 2·0 diameters.
3.	R.L.	Chilled	" 2·0 "
4.	Cammell.....	Cast steel-chilled head ...	" 2·0 "
5.	R.L.	Chilled	" 1·5 "
6.	Cammell.....	Cast steel-chilled head ...	Special No. 2 (truncated point).
7.	Whitworth	Forged steel	Head 1·5 diameters.
8.	Cammell.....	Cast steel-chilled head ...	" 1·5 "
9.	Whitworth	Forged steel	Flat head.

In each nature of shell those with the most pointed head were the best, the order of merit being assigned according to the depth of the indent made.

The flat-headed Whitworth shell was most unsatisfactory, though fired at 2 × 10 ins. of iron, instead of a solid 12-in. plate, as were the the other shells.

There were no available plates for the trial of the shells with heads of 2·5 and 3·0 diameters.

So far the merits of the respective materials stood very much where they did in the earlier experiments. One Whitworth and one Cammell shell were practically perfect after hitting the target with a velocity of more than 1500 f.s., and making indents of 15·3 ins. and 17·92 ins. (shell lodged in plate) respectively. The Whitworth had a head of 2·0 diameters, and the Cammell a head of special No. 1 pattern.

The result of *b* was as follows:—

1. When line of fire was at an angle of 37° 4′ to the normal to the plate.

Order of merit.	Shell.	Head.
1.	R.L.	2·0 diameters.
2.	Whitworth	2·0 "
3.	"	1·5 "
4.	R.L.....	1·5 "

2. When line of fire was at an angle of from 29° 30′ to 31° 30′ to the normal to the plate.

Order of merit.	Shell.	Head.
1.	R.L.....	2·0 diameters.
2.	"	1·5 "
3.	Cammell	1·5 "
4.	Whitworth	1·5 "
5.	B.L.....	2·5 "
6.	Whitworth	Flat.
7.	Cammell	Special (No. 1), 1st round.
8.	R.L.....	3·0 diameters.
9.	Whitworth	2·0 "
10.	Cammell	2·0 "
11.	"	Special (No. 2) 2nd round.
12.	"	" (No. 1) 2nd "
13.	"	" (No. 2) 1st "

The 2·0 diameter head proved to be the best as far as these experiments went. The Committee were of opinion that an increased length of head, beyond 2·0 diameters, showed no decided advantage in oblique fire at wrought-iron armour at angles of 30° and upwards.

The flat-headed Whitworth shell was not superior to a shell of the same material with a 1·5 diameter head.

Two Whitworth shells remained unbroken after impact, one being the flat-headed one, but the chilled shells produced most effect on the target in spite of their breaking up.

The result of *c* was as follows :—

Order of merit.	Shell.	Head.
1.	Cammell	2·0 diameter.
2.	Whitworth.....	1·5 "
3.	Cammell	1·5 "
4.	Whitworth.....	2·0 "
5.	Cammell	Special (No. 1).
6.	"	" (No. 2).

No chilled shells were tried, as it it was known from the preliminary trials that they had little effect on steel-faced armour, when the latter was beyond their powers of perforation.

Again, a 2·0 diameter head was the best with Cammell's shells, but on the other hand Whitworth's 1·5 diameter beat the 2·0 diameter head. The special forms had very little effect.

No shells remained entire after impact. The cast-steel was broken up much smaller than the forged steel.

The result of *d* was as follows :—

Order of merit.	Shell.	Head.
1.	Cammell	2·0 diameters.
2.	Whitworth.....	Flat head.
3.	"	2·0 diameters.
4.	R.L. (chilled)	2·0 "

No shells with 1·5 diameter heads were tried, as there was only room on the target for a few rounds.

The angle of the line of fire with the normal varied from 25° to 27°. The flat-headed shell was not practically superior to the 2·0 diameter head.

All the projectiles were broken to pieces more thoroughly than in the case of direct fire at compound plates. The scoops were nearly circular in outline instead of being elongated, as was the case when firing at wrought-iron.

Conclusions.

The Committee arrived at the following conclusions with regard to the best material for armour-piercing projectiles. The Whitworth

shells of forged steel gave on the whole the best results when fired directly against wrought-iron plates, *and they alone would have carried a bursting charge behind the armour.*

The Cammell shells were slightly superior to the Whitworth shells with both direct and oblique fire at steel-faced plates, when beyond the power of either to perforate. They could not, however, in their present state of manufacture, be relied upon to remain unbroken even when perforating comparatively weak armour—that is to say, they would not with any certainty carry the bursting charge behind the armour.

The chilled shells gave the best results as to penetration when fired obliquely at thick wrought-iron plates, but they invariably broke up on impact with both direct and oblique fire.

In experiments with the 6-in. R.B.L. Armstrong gun, Whitworth shell, having a striking velocity of from 1700 to 2000 f.s., were, after impact, for the most part entire, and only slightly set up. None broke up, but out of 12 rounds two shells were badly cracked. *Curiously enough these were shells fired with low striking velocities* (*1152 and 1054 f.s.*) *against comparatively thin* (*6 ins. and 5 ins.*) *plates.*

In experiments with the 8-in. R.B.L. Armstrong gun some forged steel shells by Cammell and Firth were fired at plates with high velocities. One of Cammell's shells remained unbroken, but set up, after striking a 16·5 in. wrought-iron plate with a velocity of 2212 f.s. Another shell by the same firm set up only 0·03 in., after penetrating 12·1 ins. into a 12-in. wrought-iron plate, while a third passed through 14 ins. of iron (2 + 12 ins.), and remained entire till it broke up against a target in rear.

Against steel-faced armour the compound shells (cast-steel with chilled heads) gave rather better results than the forged steel shells, but the latter, when not unduly tried, were superior in that they could remain entire, and carry a bursting charge through the armour which it was within their power to perforate.

If steel-faced armour become generally adopted the superiority of chilled shells against wrought-iron will go for nothing, and in any case these shells lack the power of carrying their bursting charge behind the armour which they can penetrate.

The Committee stated that they had no means for forming an opinion as to the best form and material for projectiles wherewith to pierce chilled-iron armour, such as foreign powers are adopting, especially for coast batteries.

They were of opinion that for the attack of steel-faced armour it is absolutely necessary to employ steel projectiles.

Also that studless projectiles should be used for piercing armour, as in studded shells the stud-holes form lines of weakness.

Of the forms of head, Cammell's special pattern No. 1 (with sharp point) gave the best results with direct fire against iron, but failed when fired obliquely, or against steel-faced armour.

The Cammell special pattern No. 2 (with point cut off) gave no good results.

The flat-head gave the least penetration of all when fired directly

against iron, was inferior to a 1·5 diameter head when fired obliquely; and was not superior to a 2·0 diameter head when fired obliquely at a steel-faced plate.

On the whole a 2·0 diameter head gave the best results, especially with chilled shells. The limited trials with the heads of 2·5 and 3·0 diameters only showed that these were inferior to the 2·0 diameter head when fired obliquely at iron.

The Committee turned their attention to the best weight for an armour-piercing projectile in terms of its diameter.

Obviously, the weight is some function of the diameter, or $W = f(d)$. Suppose $W = ad^3$, where W is the weight in pounds, and d the diameter of the projectile in inches, a being a constant.

W must vary as the cube of the diameter, for taking the projectile for the sake of simplicity to be a solid cylinder of density, D, then

$$W = \frac{\pi d^2}{4} l D_1, \text{ where } D_1 = \frac{D \times 1000}{16 \times 1728};$$

and l = length of cylinder in inches;

but l also depends on the calibre of gun, remembering that the maximum of l depends on the twist of the rifling expressed in calibres. Hence $l \propto d$, or $l = bd$, where b may vary between 2 and a superior limit, usually not exceeding 3·5, depending on the twist of the rifling.

Therefore, $$W = \frac{\pi d^2}{4} \times bd \times D_1;$$

or if $$a = \frac{\pi b D_1}{4},$$

$$W = ad^3.$$

The Committee thought that the value of a was somewhere beyond 0·364, but this seems hardly borne out by the tables cited, in the sense that this value of a seems somewhat low: perhaps on the whole $a = 0{\cdot}400$ would seem to be a better value for a low limit.

The respective advantages of heavy and light shells may be said to be as follows, assuming the powder charge to be constant:—

The heavier shell, though starting with a lower M.V., keep up their velocity better than the lighter ones, and so have a longer range of penetrative effect.

The lighter shell have a higher velocity at short ranges and a flatter trajectory, also a great number of projectiles can be carried for a given weight. This last advantage, however, lies in very narrow limits.*

---

* These are only the main considerations, there are various minor ones, and to attempt to lay down a hard and fast line for the value of $\frac{w}{d^3}$ would, with our present knowledge, be presumptuous. To go into the matter thoroughly would require a separate paper.

Table showing the Value of $\frac{W}{d^3}$ *for Palliser shells in Service.*

Gun.	Approximate value of W. lbs.	d. ins.	$\frac{W}{d^3}$.	If $W = \cdot 41 d^3$ the weights would be lbs.
12·5-in.	800	12·425	·4171	788·26
12·0 " (35-tons)	700	11·925	·4128	695·18
12·0 " (25-tons)	600	11·920	·3543	694·41
11·0 "	530	10·925	·4065	534·62
10·0 "	400	9·920	·4098	400·24
9·0 "	250	8·920	·3523	290·99
8·0 "	180	7·920	·3623	203·69
7·0 "	115	6·920	·3470	135·86

Perhaps the best shell would be one which could combine a fairly flat trajectory with a striking velocity of 1000 f.s. at about 2500 yds. range, being made as long as the twist of the rifling would allow it to be, so as to be able to carry as large a gun-cotton bursting charge as possible, due regard being had to the proper strength of the walls and head to which the amount of cavity for the bursting charge must always be subordinate. The projectile must, of course, not be so heavy as to strain the gun unduly, but this is easily avoided by the use of slow burning powder and proper air-spacing.

The Committee wished to have further experiments made to determine the best value for a.

It was found that when firing obliquely at wrought-iron that, if the angle made by the line of fire to the normal to the plate was 37° 4′, and the plate was beyond the power of the gun to perforate, only scoops were made on the face. When the angle was reduced to about 30°, all the natures of shell tried bit the plate. Some scoops were made, but it was thought that these were probably due to deformation on impact. Possibly they were due to the helical motion of the projectile at short ranges.

When the plate was below the power of the gun the projectiles bit at a greater angle. A plate 8·7 ins. thick was almost perforated at an angle of 35° and 36° 30′, but at an angle of 40° a scoop was produced.

The Committee believed that thinner plates could be perforated at much higher angles, and this belief is borne out by the results of the Nordenfelt and Hotchkiss trials.

With steel-faced plates *beyond* the power of the gun only scoops were made with angles of obliquity of from 25° to 27°.

When the plates were *below* the power of the gun the steel-face ceased to deflect the projectiles. A plate of 3½ ins. steel welded to 5½ ins. iron was perforated at angles of 20° and 25°.

It was considered on the whole that a good 9 or 10-inch compound plate was about equal to a good 12-in. iron plate for resisting a single blow, but that it was decidedly inferior when repeated blows were given.

The same seems to hold good when the fire is oblique. A compound 10-in. plate was broken up by six blows on 48 sq. ft., amounting to an average of 554 ft. tons per sq. ft., whilst a 12-in. iron plate was capable of taking on a surface of 128 sq. ft. an average of 992 ft. tons per sq. ft. delivered in 29 blows.

From experiments with steel and chilled iron projectiles a diagram is given in the report showing the penetrative powers of 9-in. and 13-pr. R.M.L. guns, and of the 8-in. and 6-in. Armstrong guns, when fired against unbacked wrought-iron plates. The following charges and projectiles were employed:—

Gun.	Charge.	Projectile.
9-in. M.L.	75 lbs. P^2	268 lbs.
8 "	90 lbs. P.....	182·5 lbs.
6-in. B.L.....	33 "	80 lbs.
13-pr. M.L.	$3\frac{1}{8}$ lbs. R.L.G.[2]	$13\frac{3}{16}$ lbs. $10\frac{3}{16}$ "

The 9-in. gun can penetrate 12 ins. at the muzzle.
9·1 ins. at 1800 yds.
7·25 " 3700 "
6·4 " 5440 "
4·8 " 10000 "

The 8-in. gun (Armstrong) 14·8 " the muzzle.
10·8 " 2000 yds.
9·25 " 2900 "
6·9 " 5100 "
4·5 " 10400 "

The 6-in. (Armstrong)..... 10·8 " the muzzle.
6·85 " 1500 yds.
6·2 " 2300 "
4·43 " 4700 "
2·8 " 9700 "

	Heavy projectile.	Light projectile.
The 13-pr. M.L.....	4·75 ins. at muzzle ...	4·5 ins. at muzzle.
	3·27 " 900 yds....	2·9 " 900 yds.
	2·9 " 1300 " ...	2·6 " 1200 "
	1·93 " 3380 " ...	1·75 " 2830 "
	1·10 " 7183 " ...	0·95 " 5800 "

Experiments were made with a view of ascertaining whether it was feasible to employ bursting charges of wet gun-cotton in armour-piercing shells, the charges being exploded by a delay-action percussion fuze screwed into the base of the shell, and containing a 2-oz. dry gun-cotton primer.

Several fuzes were tried differing chiefly in strength and size of slowing chamber. All more or less resembled the delay-action fuze, recently introduced for the base of 64-pr. battering shell, in their

internal arrangements. In the fuzes intended to fire wet gun-cotton of course dry gun-cotton and a detonator had to be used.

The object of the delay action was to allow the shell to get clear away from the gun before exploding, in the event of the fuze acting prematurely; and to allow the shell to penetrate a ship's armour before exploding, thus tending to blow off the armour plates within. It was obviously necessary to use shell which did not break up on impact, so Whitworth forged steel shells were employed.

Certain preliminary experiments were made, which established—

(1) That a dry gun-cotton primer and detonator could be put in the base of the shell, so as not to explode on impact against armour. It followed from this that the construction of a delay-action was possible.

(2) That a bursting charge of powder in a steel shell could not be restrained from igniting on impact, even when enclosed in several layers of serge or silk cloth.

(3) That the bursting charge of powder which could be contained in an armour-piercing projectile could not break up tough steel shells.

(4) That a shell containing wet gun-cotton (17 p.c. moisture) would not ignite on impact against armour.

The trials with shells filled with wet gun-cotton, and fitted with fuze and primer, &c., complete were now proceeded with.

Five Whitworth shells were fired in this condition, each held about 3 lbs. 6 ozs. of wet cotton.

The results of the trials were—

First, as to security to the gun. No shell exploded till after impact with the target, and so far the result was satisfactory, but the small number of rounds made it impossible to state dogmatically that there was no risk to the gun in the use of such shells.

Secondly, as to the amount of delay between the impact of the shell and its explosion. The amount of delay expected from the fuze was 5 secs., and one did so act when ignited at rest in a shell filled with wet gun-cotton. In the firing, however, this amount of delay was obtained in no instance, barely enough being obtained to allow the shell to get through the plates. The Committee thought that this might be due to the fuze composition having to burn under great pressure, and that more satisfactory results might be obtained by allowing a larger slowing chamber, or providing some means of escape for the gas. Possibly, however, the shock of impact disintegrated the fuze composition, and made it burn almost instantaneously. It was recommended that, if possible, some mechanical means of obtaining delay should be tried, as involving less risk.

Thirdly, as to the destructive effect produced by a bursting charge of wet gun-cotton, as compared with one of gunpowder in shells of similar capacity, it had been shown that gunpowder was useless as a bursting charge in good steel shells, as it failed to break them up, while gun-cotton did so.

Three shells were fired into a tunnel target consisting of 2-in. wrought-iron plate in front of and touching an 8-in. plate. The walls were formed of wrought-iron blocks 12 ins. thick, having 2-in. diaphragms of wood crossing the tunnel at every 4 ft. The back of the tunnel was a sand butt, and it was roofed in with wood.

The three shells were—

1. A Whitworth shell with gun-cotton charge.
2. A R.L. chilled shell with gunpowder charge (3 lbs. 11 ozs.)
3. A R.L. chilled shell with sand inside.

All three shells did about the same amount of damage, but this does not militate against the employment of gun-cotton in shells whose capacity is larger than that of the comparatively small 9-in. shell.

Recommendations.

The Committee made the following recommendations :—

1. That all chilled projectiles be made of the material used in the "R.L. improved" chilled shell.*
2. That all battering projectiles be made with heads struck to a radius of 2·0 diameters, and that for the 9-in. guns and upwards they be made studless, and fitted for a rotating gas-check.†
3. That the question of a delay-action fuze for use with shell containing gun-cotton bursting charges for the attack of thick and compound armour be further investigated.
4. That a proportion of forged steel shells (of a quantity not inferior to those which gave the best results in the experiments) form part of the ammunition provided for all guns likely to be employed against thick and compound armour. The proportion to be governed by the success of the investigation in (3), and the extent of the adoption of compound armour.‡
5. That cast-steel be not adopted as an armour-piercing material until it can be shown that it is more capable of remaining entire after impact than it is at present.
6. That in armour-piercing projectiles capacity for bursting charge be less considered, within certain limits, than strength of head and walls.
7. That, in future experiments with guns of greater calibre, that the proper proportion of diameter to weight in armour-piercing projectiles be investigated.

The Committee look upon these experiments as preliminary to future important experiments with heavier guns.

---

* There is no reason to suppose that these were really much better than shells made with the ordinary mixtures. Very special pains were naturally taken with the shells known to be intended for competition at Shoeburyness. (See also foot note to p. 479.)

† That is to say, a gas-check which imparts rotation to the shell.

‡ This seems to be an absolute necessity if steel-faced armour is adopted by any foreign maritime power. It has been shown that chilled iron shells are useless against it unless the armour is well under the power of the gun.

APPENDIX.

Besides the rounds previously detailed there were fired—

From the 9-in. gun.

Whitworth.				R.L.				
Studded. 1·5 diam.	Studless. 1·5 diams.	Studless. 2·0 diams.	Flat.	Studless. 1·5 diams.	Studless. 2·0 diams.	Studless. 2·5 diams.	Studless. 3·0 diams.	Studded, Serv. studd.	Studded, with wt. irn. cap.
2	6	9	3	10	10	1	2	2	3

48

Cammell.				Vicker's cast-steel.
1·5 diams.	2·0 diams.	Special No. 1.	Special No. 2.	1·5 diams.
4	6	4	5	2

21

From the 6-in. Armstrong B.L. Gun.

Forged steel (E.O.C.)	Chilled (E.O.C.)	Cast steel (E.O.C.)
14	16	2

32

From the 8-in. Armstrong M.L. Gun.

Chilled (E.O.C.)		Cammell's forged steel.		Firth's forged steel.	
1·5 diams.	2·0 diams.	1·5 diams.	2·0 diams.	1·5 diams.	2·0 diams.
38	5	4	1	4	2

54

From the 13-pr. M.L. Gun.

Chilled (E.O.C.) 1·5 diams.	
Heavy.	Light.
13	13

26

Total	181
Add rounds previously detailed (33 + 41)	74
Grand Total	255

Shells by Various Makers.

R.L.	39	Hadfield	5	Gregorini	5
Whitworth	36	Grüson	3	Finspong	3
Cammell	38	Landore	2	E.O.C.	103
Firth	10	Vickers	4		
Terre-Noire	5	Krupp	2		
	128		16		111

Total 255

TRANSLATIONS OF REPORTS OF EXPERIMENTS, &c., WITH ARMOUR-PIERCING PROJECTILES, CARRIED OUT IN RUSSIA AND HOLLAND DURING THE LAST TWO YEARS.

(*Revue d'Artillerie, September, 1878, p. 572*).

TRANSLATED BY

CAPT. W. M'CLINTOCK, R.A.

RUSSIA.—The manufacture of 9-inch and 11-inch steel shells.

The results of the experiments in France, in 1875, with projectiles supplied by the Terre-Noire Steel Company, and of those at Kronstadt, in September, 1877, with the 9^{po} (9-in.) mortar, proved that with vertical fire against horizontal armour, steel projectiles have an undoubted superiority over those of chilled iron, the latter breaking up entirely on impact.

The "*grand-maitre de l'artillerie*" had recognised the necessity of providing guns mounted on coast defences with a large number of steel projectiles, but as their cost was very great, he had directed the Russian firms to attempt the manufacture of steel projectiles, not forged, similar to those of Terre-Noire; this Company having offered to deliver them in Russia at the rate of 18 roubles per poude (4 fr. 40 c. the kil., or about 1s. 7d. per lb.)

In 1877, Messrs. Mendelew & Isnoskow contracted to supply 500 steel shells of 11^{po} (11-in.) with lead coating, at the rate of 360 fr. (£14 8s. 0d.) each; 1250 of 9^{po} (9-in.) at 238 fr. (£9 10s. 5d.) each, and 820 of 28^{cm} (for the 11^{po} gun, made in 1877), with copper rings, at 480 fr. (£19 4s. 0d.) each.

However, these manufacturers encountered so many difficulties, and the trials they were obliged to make in order to obtain projectiles equal to those of Terre-Noire were so costly, that the Russian government agreed to pay them 10 roubles per poude (2 fr. 45 c. the kil., or about 10½d. per lb.) for the 9^{po} shells, and 8 for the projectiles of a higher calibre (2 fr. the kil., or about 8¾d. per lb.)

About the end of August, 1877, the factory began the manufacture on a large scale. The steel is melted in Martin-Siemens furnaces, and iron containing manganese and silica is added. The projectiles are

cast by means of a syphon, which fills several moulds at the same time, which are placed on a movable iron platform. The interior of the shell is formed by means of a conical core.

In order to drive out all air bubbles, and to render the metal most dense, the liquid steel in the mould is compressed by means of a hydraulic press, and the moulds have thick walls so that the cooling shall not be too rapid.

(*Taken from "Journal d'Artillerie Russe."*

(*Mittheilungen, 1879—2nd number*).

RUSSIA.—Comparative trial with 9-in. projectiles against armour-plates.

In June, 1878, trials were made on the Wolfsfelde with 9-in. projectiles against an armour-plate target, in which the line of fire differed from the normal to the face of the plate.

The object of the trial was to test the quality of different metals for the production of battering shells, to compare the penetrative power of projectiles with different forms of head, and, lastly, to compare solid shot with shell.

The following were provided for the trial :—

1. Projectiles manufactured by Messrs. Putilofsky & Co., part from Bessemer steel, and part from Martin steel. Some were forged, and some not forged, some with pointed heads, and some with blunt heads (flat-heads ?)
2. From the Nobel factory, chilled projectiles hardened by different methods. These were both shot and shell, and were fitted with either lead coating or copper rings.
3. Projectiles from the French factory of Terre-Noire, of Martin steel, which were hollow and had a pointed head.
4. Projectiles from the Sormofsky factory, Benardaki; which were the same as No. 3.
5. Projectiles from the factory of Messrs. Mendeljejew & Isnoskof, which were the same as No. 3, with lead coatings.

The armour consisted of 4 plates, each 7 ins. thick, and were manufactured in the Yzorsky factory for the frigate "Menin." Each plate was fastened with 10 bolts, $2\frac{7}{8}$ ins. in diameter, to a backing of deal 35 ins. thick.

The target was 116·6 yds. from the gun. The charges were such as to give the same blow on the target as the charge of 67·7 lbs. prismatic powder of 1·75 density at ranges of 3032·6 and 2302·7 yds.

The line of fire made an angle of 25° with the normal to the target.

The trial gave the following results :—

1. *Shells with pointed heads.* The results obtained with these, with a charge of 30·6 lbs., corresponding to a range of 3032·6 yds., are shown in table. In continuation of the trial with these, and a charge of 33·8 lbs. corresponding to a range of 2302·7 yds., the following results were obtained:—

Those projectiles of Nobel, chilled over their entire surface, perforated the plate and backing, but broke up, and the pieces were found 467 yds. behind the target.

Cast-iron projectiles of the same factory with chilled heads perforated the target, and were found 583 yds. in rear. Pieces were broken from the body of these shells without the inner cavity being broken into.

Nature of Projectile.	Depth of indent.	Remarks as to the effect on the projectile.
	inches.	
Nobel's chilled shells, chilled over the whole surface	22·8	Shell broke up into small pieces.
Do. do.	14·0	Shell broke into large pieces. The head stuck fast in backing, whilst the base rebounded.
As before, but with only the head chilled	16·0	Shell broke into large pieces.
Messrs. Putilofsky & Co.'s shells of Bessemer steel, not forged.....	17·0	Shell broke up.
From same Firm, but of soft forged steel	3·8	The point was deformed, and shell broke up.
Terre-Noire, of Martin steel, cast solid, bored out and tempered ...	10·4	Shell rebounded entire.
Do. do.	36·6	Shell, entire, stuck in backing.
Do. do.	34·8	Shell stuck in backing, cracked at base.
Sormofsky. Martin steel, forged and bored out	9·5	Shell glanced along plate and broke up.
Mendeljejew & Isnoskof, cast steel, not forged or tempered	4·1	Point was deformed, and shell broke up.
Same—cast steel tempered.	7·5	Point much deformed, and shell broke up.

The steel shell of *Putilofsky* gave the same results as the chilled shells, *i.e.*, they perforated the target and were found broken up 233 yds. behind it.

The *Terre-Noire* shells perforated the target and were found entire 467 yds. behind it. The heads were slightly deformed.

2. *Shot with pointed head, and shells.* Four shot were fired with a charge of 30·6 lbs., and having an equal energy to that of the shells of the above series. The factory of Putilofsky made two of these shot from Martin steel, whilst the Nobel factory made the other two of chilled iron, having different degrees of hardness. One of the two first mentioned shot perforated the plate and stuck in the backing apparently entire, except that a small piece was broken off the base; the depth of indent was 24·9 ins. The second shot in passing through the backing turned towards the side, and the head and part of the body stuck in the backing. The base rebounded in pieces.

The shot manufactured by Nobel broke up on impact, but perforated the plate, and head and pieces stuck in backing. The depth of indent of the one was 14 ins., and of the other a little more.

3. *Shells with pointed and blunt (flat?) heads.* For this trial both shot and shell with blunt heads were provided; however, only the latter were made use of, because, in the trials already carried out, sufficient results were obtained for comparison between shot and shell having pointed heads, besides only a small portion of the plates remained uninjured, so the trial had to be confined to the most important question, viz., shells with flat heads. These, with a charge of 30·6 lbs., gave the following results :—

(*a*). Steel shell of Sormofsky penetrated the plate and broke up, the head, as far as the front ring, sticking in the backing.

(*b*). One steel shell of Putilofsky perforated the plate and stuck in backing, but was cracked. The indent was about 17·5 ins. in depth; the effect of a second shell of the same manufacture was about equal to that of the first, but produced an indent 22·6 ins. deep.

(*c*). The cast-iron shell of Nobel, with chilled head, penetrated the plate and was broken in bits, the head sticking broken in the plate.

(*d*). The shells chilled over the whole surface, made by the same firm, had nearly the same effect as with (*c*), but with this difference, that the head stuck in the plate and backing, and the indent was deeper. The head was found broken up.

The trials with shells of Putilofsky were now repeated, but only with the charge of 33·8 lbs., by which the two shells supplied (although they penetrated deeper than when fired with the charge of 30·6 lbs.) did not perforate the backing, and were broken up. The plates were much bent by these rounds.

The Russian Artillery Committee formed the following conclusions on the results of the trials :—

(*a*). The comparative trial with 9-in. shells with pointed head, when the line of fire differs from the normal, shews (as was to be expected) that the effect of the shells was not uniform, and that it depends on the quality of the material and manner of manufacture. The shells can be divided into three groups—considering the effect they produced :—

1st. Those which perforated the plate and backing, and remained entire.

2nd. Those which produced considerable effect on the plate and backing, but were broken up.

3rd. Those which were either set up or broken up on impact, and had slight penetrative power.

The French steel shells are in the first group. In the second group belong the chilled shells and unforged steel shells of Putilofsky, of which the former are to be preferred. With the chilled shells there was no appreciable difference (as shown by the trials with charges of 30·6 and 33·8 lbs.) when the whole surface was chilled, or when the chill was confined to the head.

In general, the following is to be remarked referring to this group :— Projectiles which break to pieces on impact cannot possess their full destructive effect, as a part of their work is taken up in breaking up

themselves; where a bursting charge is required to be used, such projectiles are quite unsuitable, as the effect of the bursting charge would be rendered quite useless by the breaking up of the shell. Also with shells which break up on impact, the effect will be greatly diminished through the angle which they make with the face of the plate being lessened.

Taking this into consideration, the artillery committee decided that, for the equipment of guns for coast defence, such projectiles are required which do not break up on impact, and the trials show that this condition can only be satisfied by the use of steel shells similar to those produced by the Terre-Noire factory.

In the third group are shells of soft forged steel, supplied by Messrs. Putilofsky & Co., the tempered shells of the Sormofsky factory, and the untempered shells of Messrs. Mendeljejew & Isnoskof; all these projectiles produced a less effect than those made of chilled iron.

(*b*). In comparing the effect of shells and shot having pointed heads, it is evident that steel shot are better than shell made of the same material; and that cast-iron is quite unfit as a material for shot.

(*c*). The results of the comparative trials with blunt-headed shells show that cast-iron is not a suitable material for such shells, and that steel gives the best results; it is, however, to be remarked that the steel shells, supplied by Messrs. Putilofsky & Co., when fired with a charge of 30·6 lbs., perforated the plate and entered the backing without breaking up, while with the heavier charge of 33·8 lbs., the shell broke up, although the depth of indent was more considerable than with the smaller charge, and the plate was somewhat bent.

(*d*). For comparison of shot with pointed heads, and shells with flat heads, the trials did not afford sufficient data.

(*e*). In the Russian artillery, in the equipment for guns for coast defence, no bursting charge is provided for shells with pointed heads, because, up to the present time, no means has been found to lessen the quickness of ignition at the moment of impact. However, as the attempt to overcome this defect has not yet been given up in Russia, *shot* with pointed heads have not been definitely introduced, although they (when made of good steel), with oblique fire, gave better results than shells with pointed heads.

As to projectiles with blunt heads, owing to insufficient experience, the question has still to be examined. The trial with such projectiles of steel (never of cast-iron) must be carried out using different angles of impact.

(*f*). Although, as was to be expected, when the angle of impact is lessened, such projectiles have a decided advantage over projectiles with pointed heads; still, on the other hand, it is very probable that the accuracy might not be sufficiently correct when using blunt-headed projectiles; only a trial can settle this question.

(*g*). Although in the above trials the steel projectiles of Russian factories are inferior to the French manufacture, and in some cases were worse than the chilled iron projectiles, still this is no proof (?) that Russian factories cannot produce steel projectiles equal in quality to the French.

Considering that shells with pointed heads (made from a uniform French steel) produced a considerable effect with oblique fire, and are, in this respect, much superior to chilled projectiles, it appears to be necessary for the present to retain the established proportion of projectiles for the different guns for coast defence. For every mortar one half of the number of projectiles should be of ordinary cast-iron, and the other half of steel. For every coast gun, 100 chilled, 100 steel, and 50 ordinary cast-iron projectiles are decidedly necessary.

(Taken from the Russian Artillery Journal, 2nd Number of 1879.)

RUSSIAN ARTILLERY.

(Taken from the Journal Russian Artillery.—September, 1879.

Design for a gun of 15cm. (6 ins.) calibre, to fire heavy shells with a high muzzle velocity.

Result of deliberation of the Committee of Russian Artillery on the proposal, by the Marine Department, of a gun of 6 ins. (15cm.) calibre, intended to fire very heavy projectiles with high muzzle velocities.

In the experiments carried out in England during 1878, very high muzzle velocities were obtained with a 6-in. Armstrong gun, with comparatively low pressures. The results of these experiments have caused the Marine Department in Russia to make similar trials with our 6-in. gun. As the lengthening of the gun, by means of inserting an inner tube, could not be completed at once, they have decided to profit by the delay, by determining, with a 6-in. gun, the law which regulates the dimensions of the chamber with the weight of the charge of prismatic powder of high density, the powder being provided from the powder factory of Ochta, or bought in Germany. The first series

of these experiments, which is already completed, consisted in firing increasing charges until a pressure of about 16·4 tons per square inch (2500 atmospheres) was arrived at, with a projectile weighing 91·998 lbs. and with a chamber of the service size.

The second series will be carried out in a similar manner, but with a powder chamber having a greater diameter.

In all these experiments the pressures are found by means of two Rodman gauges placed in the breech wedge, and the muzzle velocities are determined with two chronographs.

By the time these preliminary experiments are finished, the work of preparing the inner tube at the Oboukhoff foundry will be sufficiently advanced to render it possible soon to enter on the principal object of these trials.

As these trials are not of less interest to the War Department than to the Marine Department, the artillery section of the Marine Committee has considered it necessary to communicate the results of the first trials to the chief authorities of the artillery, so that the artillery committee can, if it thinks necessary, give directions as to the design of the tube with which the bore of the 6-in. gun is about to be lengthened, and as to the general direction of the trials.

The artillery section of the Marine Committee endeavoured at first to obtain, in spite of some difference in the inclination of the rifling, all the data of construction which had been communicated to them concerning the inner tube of the 6-in. Armstrong gun, of which the bore was 23 calibres in length, and had 16 grooves with an increasing twist. The inclination of these grooves at the breech is such that they make one complete turn in 91 calibres; this inclination goes on increasing until it makes one complete turn in 38 calibres, then at a distance of 7·874 ins. from the muzzle the rifling has a constant inclination of 1 in 38 calibres. As the construction of similar rifling would have given much trouble at the Oboukhoff foundry, and would have greatly retarded the completion of the gun, and as, besides, the results of a competitive trial in Austria between two siege guns of 6-in. (15^{cm}) calibre (one having uniform rifling of 1 in 45 calibres, and the other being rifled with an increasing twist) showed that although the accuracy of the first gun was a little inferior to that of the second, it was very good in both cases, they thought that they could without difficulty provide this same uniform rifling for the 6-in. experimental gun. In the opinion of the artillery section of the committee, the 6-in. gun with a uniform rifling would have given satisfactory results when firing projectiles of the Russian service form, but as the trials afterwards carried out by Krupp with a 6-in. gun showed the power obtained when an increasing twist is used, having an inclination of 1 in 25 calibres at the muzzle and with a shell 4 calibres long, it did not seem sufficient to arrange the programme for the experiments, exclusively according to the trials made in England, and it became necessary to give up the uniform rifling proposed for the 6-in. gun.

Considering that in the guns of pattern of 1877 (excepting, however, the field guns) the development of the groove is parabolic, the artillery section considered that a similar development might be given to the

6-in. guns; for this reason it asked the advice of the artillery committee as to the most suitable parabolic trace for a 6-in. gun intended to fire a shell 4 calibres in length; also, the section asked, if the artillery committee did not consider the parabolic trace for the grooves is the most convenient for manufacture, and is that actually in use at the Oboukhoff foundry; there being great difficulty in the preparation of new directrices required for each change in the inclination of the grooves. Concerning the length of bore, the depth and number of grooves, the artillery section proposed to hold to the data communicated as to the Krupp 6-in. gun, viz., length of bore, 25·4 calibres, number of grooves, 37, depth of grooves, 0·197 ins.

They propose to determine the dimensions of the powder chamber for a charge of 37·46 lb. prismatic powder, having a density of 1·75 (23·6 cubic ins. per lb.) placed in layers of 12 prisms; besides 410 grammes of powder should correspond to 0·528 cub. dec. of the volume of the same chamber, and the length of the chamber for the projectile would be fixed according to the length of a shell of 4 calibres. The form of the shells of cast-iron, chilled iron, or of steel would be calculated so that the weight of each should not exceed 112·9 lb.

After an examination of this statement, the artillery committee gave the following opinion :—

The increase in weight of the projectile, and of its muzzle velocity, much augments the destructive power of a gun of given calibre. Trials were made in England during the autumn of 1878 with two Armstrong guns, one of 6-ins. and the other of 8-ins. calibre, weighing respectively, 3·228 tons and 11·28 tons, and giving to the projectiles of 79·366 lb. and of 180·779 lb. muzzle velocities of 2001·3 f.s. and 2099·8 f.s.

In spite of these great muzzle velocities, the pressures did not exceed 9·85 tons per square inch in the bore of the 6-in. gun, and 11·15 tons per square inch in the 8-in. gun; but, so far as can be judged, the method of measuring these pressures in England (viz., by crusher gauges) gave, as showed by comparative trials in France, pressures much lower than those recorded by the Rodman gauge. By obtaining such muzzle velocities as the above, the destructive effect of the projectiles is so increased that the new 6-in. gun perforates at short ranges plates of the same thickness as those pierced by the English service 9-in. gun; whilst the new Armstrong 8-in. gun perforates plates of the same thickness as are pierced by the English service 12-in. gun. Thus the increase of muzzle velocity of the projectile renders it possible to pierce, at a short range, with a 6-in. shell the same plate which a 9-in. shell perforates, having a length of 2·4 calibres and a muzzle velocity of about 1410·8 f.s.

Considering that the velocity of a projectile can possibly be maintained at different distances by increasing its weight in proportion to each unit of surface of transverse section, Krupp tried, at the beginning of the year, two 6-in. guns, of which one fired (like the Armstrong gun) shells of the usual length with a muzzle velocity of 2132·6 f.s., and the other is intended to fire long shells with a muzzle velocity of 1673·3 f.s. The long shells of cast-iron are 4 calibres in

length, and the steel shells 3·5 calibres, so that with these two projectiles the weights are almost equal. In these trials Krupp obtained, amongst other results, the following :—

Practice with a 6-in. (15^{cm}) gun of 28 calibres in length.

Weight of projectile.	Length of projectile.	Charge prismatic powder, density 1·75	Muzzle velocity.	Velocity at 1668·9 yds.	Pressure by Rodman gauge.
lbs.	calibres.	lb.	f.s.	f.s.	tons.
69·1	2·8	37·5	2132·6	1548·6	19·05
111·1	4·0 cast-iron. 3·5 steel.	34·1	1679·8	1348·5	17·60

With the lengthened projectile the weight per unit of transverse section was 4·035 lb. per square inch, while with the projectile of 2·8 calibres in length the weight did not reach 2·514 lb. per square inch.

In order to judge of the advantage obtained by the increase of muzzle velocity and of the weight of the 6-in. shell, the committee have calculated the energy of this projectile per unit of circumference, and also the thickness of plate which it can perforate by direct fire. The results of this calculation are given in the following table :—

Calibre.	Range.	Length of shells.	Muzzle velocity.	Energy per inch of circumference	Thickness of plate perforated by direct fire.
inches.	yards.	calibres.	f.s.	f.t.	inches.
6		2·8	1679·8	39·7	5·669
"	1632·8	2·8	2132·6	62·2	7·126
"		3·5	1679·8	74·2	7·795
"		2·8	"	32·5	5·118
"	2332·7	2·8	2132·6	42·5	5·866
"		3·5	1679·8	61·3	7·087

This table shews that the increase of muzzle velocity of a 6-in. shell from 1679·8 to 2132·6 f.s. is sufficient to augment, by one quarter, the thickness of plate perforated at a range of 1632·8 yds., and by $\frac{1}{7}$th the thickness of plate at a range of 2332·7 yds.

Armstrong, as we have seen above, has not tried in his experiments a shell of increased weight, and he has obtained, by increasing the velocity, similar results to those obtained by Krupp with a shell which was not lengthened.

By increasing the weight of shell from 69·1 lb. to 111·1 lb., and preserving the same muzzle velocity of 1679·8 f.s., the thickness of plate perforated is increased $\frac{1}{3}$rd by direct fire at a range of 2332·7 yds., as well as at a range of 1632·8 yds. It is shown by this table that for a given calibre, one derives more advantage as to the perforating power of the projectile by increasing its weight, than by augmenting its muzzle velocity; indeed, the increase of thickness in plate perforated by the heavier projectile is $\frac{1}{10}$th at a range of 1632·8 yds., and $\frac{1}{5}$th at at a range of 2332·7 yds., compared with the perforation of a projectile of the ordinary weight fired with a greater muzzle velocity.

The increase in weight of shell, as tried by Krupp, diminished to such a degree its loss of energy at long ranges, that with direct fire with these projectiles one would expect the perforating power to be much greater when compared with that of shells of the ordinary length. Thus, always considering the fire to be direct, the 6-in. gun firing a shell of 3·5 calibres could perforate, at a range of 2332·7 yds., the same plate that could be perforated by a 7·7-in. gun, made after the pattern of our coast guns of 1877; the 6-in. gun firing, on the other hand, a shell of the ordinary length, but with increased velocity, would pierce at a range of 2332·7 yds. the same plate that could be perforated by a 6·693 in. gun made after the pattern of our coast guns of 1877. It must be remarked that these guns of 7·7-in. and 6·693-in. calibre would weigh much more than the 6-in. gun of Krupp.

Considering the advantage that there would be for a gun of a given calibre in having an increase in the weight of the shell, whilst preserving a sufficient muzzle velocity, the artillery committee thought that it would be very useful, as proposed by the artillery section of the marine committee, to test 6-in. shells (cast-iron 4 calibres, and steel 3 calibres in length) which should be fired from a 6-in. hooped steel gun.

According to the wishes of the section, the committee have decided on the form of a 6-in. shell of 4 calibres in length, as well as that of the bore and chamber of the gun, from which it is proposed to fire them. The rifling has been calculated so that at the muzzle it has an inclination of 1 in 25 calibres, the pressure on the projectile in the chamber would be about equal to the pressure towards the muzzle. The inclination of the rifling at the breech, calculated on this condition, has been found to be 3° 12′.

The development of the rifling on a plane surface is parabolic; this form is chosen because it could be easily obtained, without the help of a special guide, by means of two uniform rectilinear movements in two directions perpendicular to each other. After trials at the Perm foundry, this is the principle on which the rifling of our guns of pattern 1877 have been made. This will render useless the employment of templets, the form of which must change with the nature of the gun and the inclination of the rifling, and, besides replacing the

rectilinear directrices when worn out, is much more easy than in the case of these templets; lastly, it establishes one principle for different natures of guns and inclination of rifling; indeed it settles in a convenient manner the connection between the speeds belonging to the two perpendicular directrices and the position of the fixed point in the rotation of the cutter. The chamber of the proposed gun is made like that of the 6-in. gun tried by Krupp. Besides, in order to lessen the destructive effect of the charge, this chamber has been given 0·984 ins. more than the proportional length of the Krupp chamber. The diameter of the chamber is 0·748 ins. more than in the 6-in. gun of pattern of 1877.

The Oboukhoff foundry must, in order to introduce the tube, increase much the diameter of the prolongation of the bore to the rear of the wedge, and in order to prevent strain of the wedge when firing, it will be necessary to screw a screwed cylinder in this prolongation of the bore, similar to that in the Oboukhoff field guns.

The charge of prismatic powder (of usual form), by the recommendation of the committee, is to be determined so as to give a cast-iron shell of 4 calibres in length, a muzzle velocity of 1679·8 f.s. The same charge is to be used for the steel shell of 3·5 calibres.

To determine the pressure, two Rodman gauges must be placed in the wedge. The drawing of the 4 calibre shell shows the interior ribs like that of the double shells of the English artillery, in order to prevent premature explosions in the bore of the gun. The weight of these shells filled is about 112·4 lb., and the weight of the bursting charge is 6·7 lb.

As these ribs diminish considerably the capacity of the shell, the committee think it will be well to try at the same time some shells with ribs, and others without ribs, but the latter to have their walls rather stronger than as shown in the drawing. If these shells without ribs do not break up in the bore, a bursting charge of 8·1 lb. could be used. The size of the rear band has been shown on the drawing, so that the pressure on the driving side of the groove, per unit of surface, will be precisely the same as with the service 6-in. shells fired with a charge of 19·8 lb. of prismatic powder of 1·68 density.

In the experiments which the Marine Department propose to carry out with this 6-in. gun, the committee think that it will be well to investigate, as far as possible, the following questions :—

1. Are the shells of 4 calibres in length sufficiently accurate at different ranges?

2. In what degree is the efficiency of the 3·5 calibre steel shells reduced in oblique fire, comparing them with the present service shells?

3. Can special steps not be taken to lessen the re-action of the gun on the carriage, and to diminish the recoil?

Some of these questions have been partially answered by Krupp's experiments. Thus the practice at 1668·9 yds. range has shown that the mean error of the shells in a vertical direction is only 18·9 ins. The committee think that this accuracy may be considered quite satisfactory, because the practice with the 6-in. gun (firing a shell of 2·8 calibres in length, fitted with bands) gives a mean error in a vertical direction varying from 19·3 to 26·4 ins., according to the atmospheric conditions. The committee recommend, in addition, comparative practice with the naval gun, at ranges between 1093·6 and 4374·5 yds.

In order to test the shells of 3·5 calibres in length against armour, the committee recommend firing some rounds at a plate with the line of fire making an angle up to 25 degrees with the normal. The committee think, besides, that in order to place the projectiles thus tried under the same conditions, the practice should be against an iron plate target with a full charge, and at a range of 109·4 yds. For this trial a plate of good quality and a thickness of 8·5 ins. should be used. This plate should be perforated by a shell of 112·4 lb., fired at a range of 109·4 yds. at an angle of not more than 25 degrees with the normal, and with a muzzle velocity of 1679·8 f.s. With direct fire the velocity of the projectile fired at the same range of 109·4 yds. should be reduced to 1548·6 f.s.

As recommended by the committee in these trials with oblique fire, plates should not be used whose thickness is more or less than 8·5 ins., because it is necessary to subject the projectiles to severe trial, and at the same time charges not greater than the full charge should be used. To lessen the destructive action of the charge on the gun when firing such heavy shells, a very dense powder must be used; under these conditions, as shown by Krupp's trials, the pressure at the bottom of the bore of a 6-in. gun is about 17·7 tons per square inch, measured by the Rodman gauge, a pressure which is not much greater than that of 14·45 tons per square inch, as developed in our 6-in. gun with service charge and shell of 2·8 calibres in length. One may hope that by using a powder sufficiently dense, the pressure on the gun, even when firing these heavy shells, will not exceed the limit of resistance of the piece, which is laid down as 18·4 tons per square inch but as when using such a powder the pressures of the gas in sections of the bore, more or less removed from the breech, may acquire a greater value then when employing a quick burning powder, which up to the present time has been used in this gun, the committee recommend that in the ensuing trials the Marine Department should place some Rodman gauges in the bore of the 6-in. gun at different distances from the bottom of the bore, in order to determine if there be any reason to modify the position of the hoops in these new guns.

These recommendations of the committee have been approved by the *grand maitre de l'artillerie.*

(*"Bulletin de la Réunion des Officiers," 6. 12. 79., p. 1075.*)

Revue d'Artillerie, July 1878, p. 380.

HOLLAND.—Practice against Armour Plates of different kinds.

The naval service of Holland carried out during the months of August and September, 1877, some interesting experiments against armour plates submitted as samples by different manufacturers.

There were altogether six plates—two descriptions from the French factory of Marrel, two from Duus (agent to the Swedish factory of Sandvik), and one from each of the English companies, Cammell & Co., and Brown & Co.

Their dimensions are as follows:—

	Height. mètres. ft.	Width. mètres. ft.	Thickness. mètres. ins.
Marrel.....	2·65 (8·694) ...	0·91 (2·985) ...	0·254 (10)
Cammell...	2·75 (9·022) ...	" ...	0·255 (9·921)
Brown.....	" ...	" ...	0·250 (9·842)
Duus	" ...	" ...	0·234 (9·213)

The plates of Duus were of steel, and the remainder of wrought-iron.

They were arranged as follows:—

Three plates—those of Crammell, Marrel, and Duus—were placed with their longest sides vertical, and the three others, of Brown, Marrel, and Duus, with their longest sides horizontal, against a teak backing. The horizontal plates were slightly curved, to the extent of about 12^{cm} (4·724 ins.)

The vertical plates were supported by two layers of timber placed horizontally and vertically, the thicknesses being respectively 31·5^{cm} (12·402 ins.) and 30·5^{cm} (12·008 ins.), and supported behind by five horizontal balks of 20·5 ^{cm} (8·071 ins.), and four vertical balks of 39·5^{cm} (15·551 ins.). This target was solidly attached on board a vessel.

On the centre of each plate a white bull's eye was painted 200^{mm} (7·874 ins.) in diameter.

On the 21st August, 1877, the trials were commenced with a long 17^{cm} (6·693 ins.) Krupp hooped gun mounted on the gunnery ship Het-Loo; the projectiles used were Krupp shells of chilled-iron, with copper rings, weighted with sand to 59·8 kilos. (131·837 lbs.); the charge was 15·5 kilos (34·171 lbs.) of pebble-powder; the proportion of weight of charge to that of projectile was therefore about $\frac{1}{4}$th, or exactly $\frac{1}{3·85}$.

The initial velocity was 488^{m} (1601·079 f.s.); the range was 100^{m} (109·36 yds.); striking velocity was 478^{m} (1567·270 f.s.); the energy on striking was 696·4 tonnes-mètres (2249·372 ft. tons.)

Energy per centimètre of shell's circumference was 13 tonnes-mètres (106·6 ft. tons per inch of circumference).

Energy per square centimètre of section 3·03 tonnes-mètres (63·806 ft. tons per square inch of section).

The motion on board the gunnery vessel occasioned by a violent wind rendered it difficult to lay the gun; the projectiles deflected sensibly to the left, but however struck the targets. (For results see Table I.)

We must consider that the chilled projectiles of 17^{cm} (6·693 ins.) gave excellent results, as they penetrated all the plates of very good quality, having a thickness of 1½ calibres.

The wrought-iron plates are completely perforated, and the wood backing is more or less penetrated. Not a single crack is made in these plates.

The steel plates are equally perforated, though the projectiles rebounded from them either whole or in pieces. The wood backing is uninjured, but the plates are cracked, and these cracks keep increasing in size for some time after the blow is given.

The whole projectiles, as well as the fragments, were cold.

On the 8th September, 1877, the experiments were continued with a 9-in. (228·6^{mm}) Armstrong M.L. gun, mounted on the "Scorpion," at a range of 113 mètres (123·577 yds.) from the target.

The charge was 22·7 kilos (50·045 lbs.) pebble powder; the projectile was a Palliser shell weighted up to 113·5 kilos. (250·224 lbs.); the proportion of weight of charge to that of projectile was therefore $\frac{1}{5}$th.

The striking velocity was 408 mètres (1338·607 f.s.); the energy on striking was 962·9 tonnes-mètres (3110·167 ft. tons); energy per centimètre of circumference of projectile was 13·33 tonnes-mètres (109·306 ft. tons per inch of circumference); energy per square centimètre of section was 2·32 tonnes mètres (48·889 ft. tons per square inch of section). (Table II. gives the results of the practice.)

To recapitulate, in spite of the difference of calibres, the effect produced by the 9-in. shell is much less than that obtained with the long 17^{cm} hooped gun, the only plate perforated (except when the projectile struck on a corner, or on a hole already made) was a horizontal Marrel plate, at the 7th round.

The Palliser projectiles are inferior to the Krupp projectiles; they

were almost all broken up, even those which struck on holes already made, or on the edges of the plates, and they broke up into very small fragments, which were much heated.

The steel plates ended by falling to pieces, and with the exception of one Marrel plate, the wrought-iron plates were never cracked.

TABLE I.—*Practice with long 17cm hooped Krupp Gun.*

No. of round.	Nature or plate.	Effect produced on plate.	Effect on projectile.	Remarks.
1	Cammell's plate, iron, placed vertically, 9·921 ins. thick.	Projectile stuck in plate, the base sunk to depth of 11cm (4·331 ins.)	A piece broken off the base.	No cracks in plate.
10		These projectiles struck corner of plate, broke off a piece, and went obliquely through backing.	—	—
11			—	—
2	Marrel's iron plate placed vertically, 10 ins. thick.	Through plate and buried in backing, base sunk 4cm (1·575 ins.)	Base unbroken.	Plate penetrated, but there are no cracks.
9		Through plate and most of backing, base sunk to 42cm (16·535 ins.)	Base broken.	
6	Marrel's iron plate 10 ins. thick placed horizontally.	Stuck in plate, the base projecting 1cm (0·394 in.)	A piece broken off base.	No cracks in plate.
5	Brown's iron plate 9·842 ins. thick, placed horizontally.	Struck corner of plate, went through it, backing, and broke balk.	Shell broke up, fragments found behind target.	—
7		Through plate and backing	—	No cracks in plate.
3	Duus' steel plate 9·213 ins. thick placed vertically.	Point of projectile through plate.	Shell broke up and fragments rebounded from trgt.	Plate is split transversely.
8		Do do	Do	Do
4	Do do placed horizontally.	Do do	Shell rebounded whole.	Plate is cracked in many directions.

TABLE II.—*Practice with 9-in. Rifled M.L. Armstrong Gun.*

No. of round.	Nature of plate.	Effect on plate.	Effect on projectile.	Remarks.
1	Duus' steel plate, vertical 9·213 ins. thick.	Struck an old hole, went through plate backing, and overturned the structure; plate useless.	Broke into small pieces found behind target.	Plate cracked in many places.
4	Duus' steel plate, horizontal 9·213 ins. thick.	Struck upper edge of plate, went through backing and set it on fire; plate useless.	—	Do
2	Marrel's iron plate placed horizontally, 10 ins. thick.	Struck lower edge of plate went through backing and upset supports.	Broke up, pieces fell behind target.	No cracks.
3		Struck high on right, did not penetrate; point buried in plate.	Broke up, pieces rebounded.	One crack in plate.
7		Struck high on left, went through backing, and upset supports.	—	No cracks.
5	Marrel's wrought-iron plate placed vertical, 10 ins. thick.	Struck right lower edge of plate, did not penetrate, point buried in plate.	Broke up.	Do
6		Struck left lower edge of plate, near old hole, and penetrated backing.	—	Do
9		Point remained buried in plate.	Broke up.	Do
8	Brown's wrought-iron plate, horizontal, 9·842 ins. thick.	Struck left upper edge of plate, and penetrated plate and backing.	—	Do
10	Cammell's iron plate, vertical 9·921 ins. thick.	Struck lower edge of plate and did not penetrate.	Broke up.	Do

DUTCH TRIALS OF COMPETITIVE PROJECTILES.

From the Dutch,

BY

LIEUT.-COL. Le Fer TAYLOR, R.A.

A report has recently been printed by the Dutch Government on the trial, against armour, of projectiles supplied by Ekman of Finspong, Krupp, and Grüson. The experiment took place at Scheveningen, on June 16th, 1879. It has a special interest from the fact that the projectiles were all fired with a reduced velocity, calculated purposely to give bare penetration as nearly as possible. We have results obtained with the new 8-in. and 6-in. Armstrong guns, which we propose to notice shortly, where the same idea was carried out, beginning at about the same thickness of plate, but increasing up to a very high standard. The Dutch experiments, if they did not embrace an ambitious programme, were at all events carefully carried out, and are therefore

FIG. 1

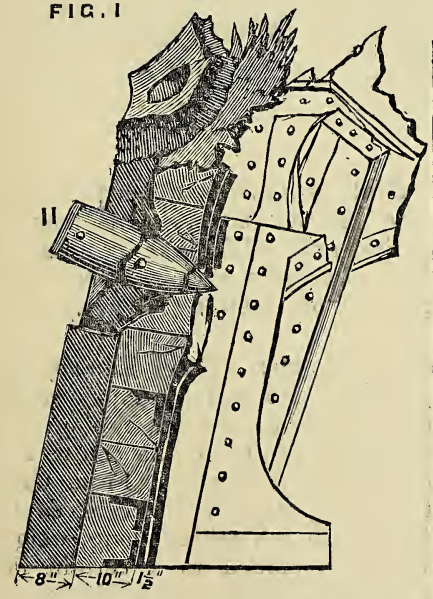
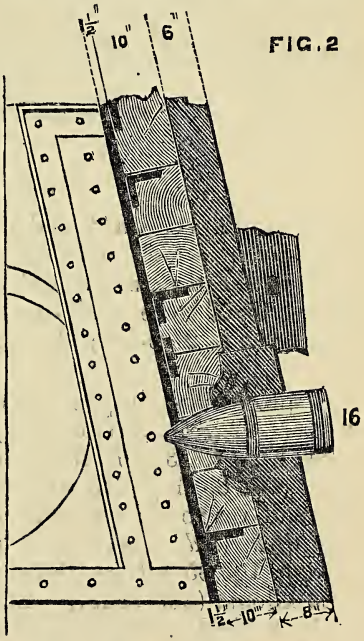


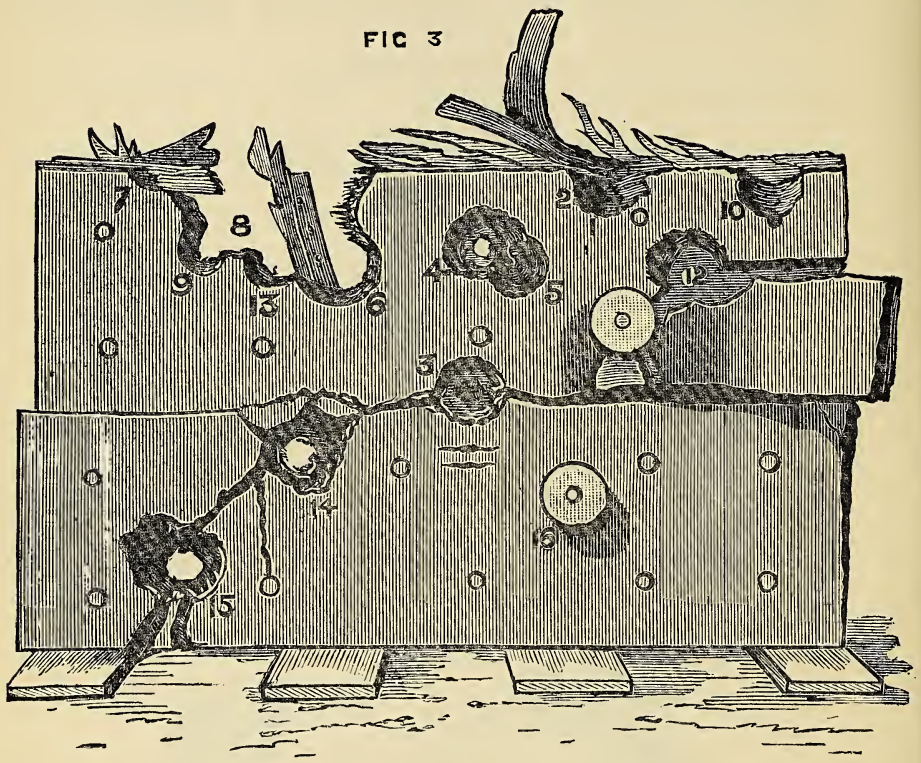
FIG. 2



instructive. The plate fired at is shown in Figs. 1, 2, and 3. It

consisted of a section of our English Bellerophon target, namely, iron plate of 6-in. and 8-in. above and below, (as shown in Figs.) on 10-ins. of teak, with 1½-in. skin. For this, a penetrating figure of 60 ft.-tons per

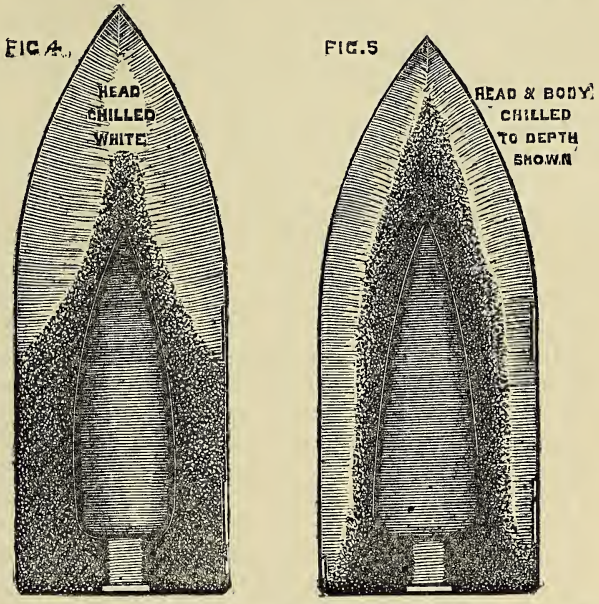
FIG 3



inch circumference was found to be sufficient for the upper portion, and 93 ft.-tons per inch circumference enabled the projectile (shown in Fig. 2) to get its point through the inner skin of the lower portion. The guns employed were a cast-iron and a steel gun, each of 24 centimètres calibre, that is, 9·45-in.; the range was 500 mètres (547 yds.)

The projectiles supplied were as follows: — From Ekman, *chilled iron* (*vide* Fig. 4) of two sizes, namely, 2·6 calibres long, weighing 152·34 kilogs. (325·73 lb.), and 2·8 calibres long, weighing 152·34 kilogs. (335·85 lb.) These were chilled nearly to the centre in the head, and the body was left unchilled (*vide* Fig. 4.) From Grüson, *chilled iron* (*vide* Fig. 5) of two sizes, namely 2·6 calibres long, weighing 149·65 kilogs. (329·93 lb.) and 2·8 calibres long, weighing 153·85 kilogs. (339·18 lb.) These were chilled to a certain depth over both head and body, as shown in Fig. 5. From Krupp, *steel*, 28 calibres long, weighing 161 kilogs. (354·94 lb.)

More was expected from the steel projectiles than the chilled ones. They were heavier, and were fired with a higher charge at the lower



portion of the target from the steel gun, which was polygrooved, the projectiles being rifled by means of copper rings near shoulder and base, as seen in projectile in Fig. 2, whereas the chilled projectiles had studs, being fired from the cast-iron gun at the upper portion of the target.

In all seventeen rounds were fired, namely, four heavy and one light of Ekman's, five heavy and three light of Grüson's, and four of Krupp's. The following table gives the details :—

No. of round and maker.	Weight of charge. Kilogs.	Weight of projectile. Kilogs.	Striking velocity. Metres.	Stored up work in ton metres per cent. of shot's circumference.	Remarks.
1. Ekman	16	147·75	266·9	7·116	Struck near top.
2. "	"	152·34	266·4	7·311	"
3. "	"	"	264·7	7·196	Struck junction of plates.
4. "	"	"	267·4	7·363	Fairly through.
5. Grüson	18	149·65	290·3	8·527	Struck close to 4.
6. "	"	"	290·3	8·527	Fairly through.
7. Ekman	"	152·34	285·9	8·416	Struck top edge.
8. Grüson	"	153·85	287·3	8·584	Fairly through.
9. "	"	"	288·7	8·669	Through.
10. "	16	"	266·3	7·378	Struck near top.
11. "	"	"	262·3	7·159	Just through (*vide* Fig. 1).
12. "	"	"	267·1	7·420	Through.
13. "	"	149·65	271·9	7·482	Through weak place.
14. Krupp	22·3	161	323·0	11·367	Through thick portion.
15. "	"	"	321·5	11·248	Barely through.
16. "	"	"	322·6	11·326	"
17. "	—	—	—	—	Not given.

The following conclusions was arrived at as regards the calculated penetration, namely, that a projectile discharged from the cast-iron gun, with a velocity of 373 mètres, or 1224 ft., would pierce the 6-in. plate at about 1800 mètres (1969 yds.) range; and a heavier projectile from the steel gun, fired with a velocity of 472 mètres (1549 ft.), would pierce an 8-in. target and backing at about 1800 mètres (1969 yds.)

As regards the projectiles, none of the Ekman (Finspong) chilled-iron projectiles were broken up on impact, except that the point of one was broken off to the length of 142^{mm} (5·6 in.). The remainder of the projectiles underwent no alteration in form beyond setting up to the extent of 6^{mm} (0·236 in.) in length. Of the eight Grüson chilled-iron projectiles, seven broke up into a great many fragments, while one, which remained entire, showed a crack along the tapering portion about the shoulder of it, but was set up in length only 2^{mm} (0·079 in.) The Krupp steel projectiles all remained entire. They underwent a slight deformation, setting up longitudinally to the extent of from 23^{mm} to 28^{mm} (0·866 in. to 1·102-in.), while above the shoulder the diameter increased to the extent of from 1·5^{mm} to 2·5^{mm} (0·059 in. to 0·098 in.); also all the points for a length of from 16·5^{mm} to 21·5^{mm} (0·64 in. to 0·84 in.) were deformed. The Swedish projectiles of Ekman were considered very superior to those of Grüson. The committee found it difficult from these experiments to say whether the steel showed a superiority sufficiently decided to justify their high price as compared with the chilled projectiles.

With regard to this report, it may be remarked that the behavour of the Finspong projectiles to a certain extent agreed with the results obtained in our own English competitive trials, that is to say, the Grüson's projectile was harder than the Finspong. At Shoeburyness, in 1878, one Grüson shot broke up badly, but another did remarkably well (*vide* "The Engineer," April 12th, 1878.) The Finspong metal is, of course, remarkably excellent; but no observation is made in this report as to its price. The chilling of the body, still retained by Grüson, has been abandoned long ago by most manufacturers. In the abstract, the unchilled metal having the advantage in tenacity and the chilled metal in hardness, it would seem sound to retain a little unchilled in the centre, to hold the shot together, while the entire ring of chilled metal might prevent setting up. Practically it has been found better to leave the entire body mottled. The crushing strain must fall much less heavily there than in front, and tenacity throughout the body seems the desideratum.

PRACTICE

WITH THE

25MM (1-IN.) NORDENFELT MACHINE GUN,

on H. Grüson's practice ground at Bückăn, on the 22nd December, 1879.

BY

CAPT. E. BAINBRIDGE, R.A.

THE trial practice took place in the presence of the Captain Glomsda von Bŭchholz and the 1st Lieutenant (Captain-Lieutenant) Jack.

After an exhaustive explanation of the mechanism of the revolving cannon, it was stripped and assembled.

The easy access to the inner part of the gun, the possibility of turning down the upper closing plate by pressing down a spring, and of thus bringing the whole mechanism into view, make it possible in a few minutes to dismount all the moveable parts of the gun, to remount it, and to submit it thereby to a minute examination.

The solid structure of all the parts of the mechanism, the simplicity and strength of the machinery, the very little room taken up by the spiral springs exclude the chance of accidents during the passage of cartridges and projectiles through the gun, and ensure easy manipulation and great strength. The gun, with all its gear, as well as ammunition, give the impression of being thoroughly well made, which impression was justified by the following practice.

The object of the practice was to ascertain the penetrating force of this gun against wrought-iron and steel plates, both single as well as one behind the other, both at right or acute angles.

The cartridges were all loaded with large grained English rifle powder. The usual charge consisted of 625 grains (40·5 gramm), and

the increased charge of 675 grains (43·75 gramm); the weight of the steel shell, including gas-check, amounted to 207 gramm (3494 grains or ½ lb.

I. Target, ·512-in. wrought-iron plate; range, 219 yds.; number of rounds, 9; angle of strike, 49°.

Result.—Seven shots penetrated the targets with considerable energy to spare, two missed the target.

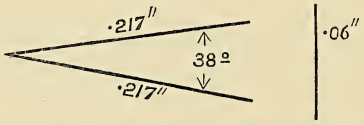
Target, ·512-in. wrought-iron plate; range, 164 yds.; number of rounds, 9; angle of strike, 30°.

Result.—Four shots penetrated the plate, three hit broadside on and were rejected, and two missed the target.

II. Target, ·236-in. steel plate standing 4 ft. in front of ½-in. wrought-iron plate; range, 164 yds.; number of rounds, 9; direction perpendicular.

Result.—Steel plate penetrated by all the projectiles, and the wrought-iron plate penetrated by seven, partly hit broadside on, whilst two projectiles grazed against the supports of the first target, and were rejected.

III. Target, combined ·217-in. and ·06-in. steel plates, representing a torpedo boat.



Range, 164 yds.; number of rounds, 10; direction, 19° to surface of target.

Result.—Eight projectiles penetrated the steel plate, some tearing large holes; one of them only hit the ·06-in. steel plate, and penetrated with energy to spare, the other two missed the target.

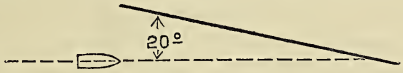
IV. Target, two ·197-in. steel plates placed parallel at a distance of 11½ ft. from each other, representing the two sides of a torpedo boat. Range, 164 yds.; number of rounds, 10; direction, 45°.

Result.—First plate penetrated by all projectiles, and second plate by seven projectiles, mostly hit broadside, two were rejected for hitting sideways, and one missed.

V. Target, ·197-in., ·216-in., and ·236-in. steel plates, put parallel one, two, and four feet behind each other. Range, 164 yds.; number of rounds, 9; direction, perpendicular.

Result.—First and second target penetrated by all projectiles, third target by seven projectiles; only two hit the third target, they were broadside on, and were rejected.

VI. Target, three ·197-in., and ·216-in. steel plates, put in a line for rapid fire. Range, 164 yds.; number of rounds, 21; direction, 20° to the surface of the target.



Result.—Five volleys (20 rounds) were fired in five seconds, eleven of which hit the target and penetrated.

VII. Target, ·472-in. steel plate, with a ·216-in. steel plate 3·28 ft. behind it. Range, 164 yds.; number of rounds, 9; direction, perpendicular.

Result.—All the projectiles penetrated both plates. Clean holes through.

VIII. Target, ·472-in. steel plate; range, 164 yds.; number of rounds, 10; direction, first round 45°, the other 9·2°.

Result.—The first round rejected, hit sideways; of the other nine, seven penetrated, and two were rejected (hit sideways).

IX. Target, ·787-in. steel plate; range, 164 yds.; direction perpendicular; number of rounds, 1.

Result.—Only the point penetrated, and it was rejected.

Target, ·787-in. steel plate; range, 109 yds.; number of rounds 4; direction, perpendicular.

Result.—One round penetrated the plate, the three others remained fixed in it.

Target, ·787-in. steel plate; range and direction, as before, but with increased charge (675 grains); number of rounds, 4.

Result.—Two rounds penetrated the plate clean, two remained fixed in it. It was hereby shown that well hardened projectiles will penetrate a ·787-in. steel plate with but little remaining energy, those which remained fixed in the plate were much distorted, whilst the former had not undergone any alteration in form.

Rapid fire against wood targets with gun fixed.

3	series	respectively,	8	rounds in	$1\frac{3}{4}$ secs.
6	„		24	„	5 „
10	„		40	„	9 „

After this the spiral springs and the chief mechanism were examined, and found fit for use, and perfectly clean. The filling of a cartridge feed case was done by a man in 57 seconds, and the replacing it on the gun in 6·5 seconds. The weight of an empty cartridge box was ascertained to be 13·89 lbs., and that of a full one 48½ lbs.

The weight of a packing box for 96 projectiles was ascertained to be 83·776 lb., and the space it occupies is 21·85 × 7·1 × 8·6 ins.

Change of Elevation.

a. The changing of a gun from its greatest elevation of 19°, to its greatest depression of 25°, was executed by one man in 5 secs.

b. The change from 45° horizontal angle to the right, to 45° to the left, together 90°, was exccuted by one man in two secs.

Both manœuvres (*a* and *b*) were also done by a man in five secs.

The taking to pieces and remounting of the mechanism was done by one man, with slight assistance from a second, in 35 secs., and the changing of four spiral springs in 20 secs.

N.B.—In all trials with direction perpendicular to target, the projectiles went clean through the target; with the elevation at acute angles, on the contrary, the holes were very long, and the plates bent in very much.

With two and more plates put up, one behind the other, the projectiles penetrated the last plates mostly side on, with long and very irregular holes.

DESCRIPTION OF THE 1-IN. TORPEDO BATTERY GUN,

BY

CAPT. E. BAINBRIDGE, R.A.

Barrels.—The barrels, made of the best cast steel, and four in number, are placed horizontally side by side, and run parallel. They are provided with chambers to take the cartridges as described below, and are rifled according to the Henry system.

Length of barrel	38·1 ins.
Weight of barrel	31 lb.

Mechanism.—The whole function of the gun is derived from a lever which moves sideways. As soon as the lever is drawn back, the springs are held fast and a layer of cartridges falls out of their feed-case into the right position.

1. In pushing the lever gradually forward every cartridge is first brought exactly in the direction of the rear of the chamber; *secondly,* they enter the chamber, and the breech-block is pressed firmly against the bottom of the cartridge; *thirdly,* the recoil bolts are pressed into the sides of the frame; *fourthly,* the extractors are made to catch the rims of the cartridges; *fifthly,* the compressed spiral springs are released one after the other (or, if necessary, for volley firing, immediately one after the other), so that the pins strike the percussion cap and fire the four cartridges.

2. In drawing back the lever into its first position, the recoil bolts are first brought away from the sides of the frame; *secondly,* the empty cartridge cases are taken out (all four at the same time); *thirdly,* these empty cases are released by the extractors, so that they fall out; *fourthly,* the carrier is brought directly under the cartridge chambers of the feed, so that four fresh cartridges fall in; *fifthly,* when the lever is drawn back as far as possible, it again compresses the

springs, so that the gun is ready loaded for the following four rounds.

Simplicity.—The motion of every piece in the whole mechanism is sideways, and is in the same direction as the putting in and taking out of the cartridges, by which means it has been possible to make the mechanism far more simple than that of any other battery gun. The mechanism is so simple that in 20 secs. it can be completely opened and closed by one man without unfastening a single screw.

The whole mechanism can be laid open, the four springs, four hammers, and four pins can be taken out and be put in readiness for firing without the help of a single tool, by two men in less than two minutes, or by one man in less than three minutes. There are no wheels in the mechanism, the whole being worked by levers.

Strength.—All the moveable parts of the mechanism are of the best cast steel, and are so strong for the work required of them, that there is no danger of their breaking or bending.

Jamming.—All the passages for the cartridges are so roomy, and the distance they have to travel is so short, that there can be no jamming in the gun. In case a faulty cartridge should cause an obstacle or a jamming in the mechanism, it can at once be reached by the hand of the gunner, and if one or more faulty cartridges should lodge in the chambers, the other barrel or barrels can be used without interrupting the firing.

Loading.—The loading is done by means of feed cases for 40 cartridges each, which contain four chambers for ten cartridges each, so that four cartridges fall at the same time into their position in the rear of the four barrels. The feed cases can be changed in a few seconds. If required, the loading and firing can also be executed without interruption by dividing the cases in two parts (as in the 0·45-in. battery gun); the bottom part remains stationary, and supplies the cartridges, whilst the top part of the feed case is changed.

Service.—The gun can, if necessary, be loaded and fired by one man, without diminished rapidity for every 40 rounds. The work is so light that a gunner can fire any number of rounds without fatigue. Little or no practice is required, as any man can fire if he is simply taught to move the hand lever backwards and forwards.

Cleaning.—The four barrels can at any time be opened at both ends, and the barrel and chambers cleaned in 15 secs. All the parts work freely, so that they require very little oil. The mechanism is not affected by rain or dust.

The man who fires is behind it, and is protected by the gun. He fires by pushing the lever from him in a line with his shoulder, and at the time of firing his eye is by this movement brought into the line of fire. His left hand is free to determine the direction, by means of the vertical and side setting screws.

Range.—The longest range is 3000 to 3500 yds. The angles of elevation are as follows:—

Distance. yds.	Elevation. ° ′	Distance. yds.	Elevation. ° ′
100	0 10	1000	2 18
200	0 21	1100	2 38
300	0 33	1200	3 0
400	0 45	1300	3 23
500	0 58	1400	3 47
600	1 12	1500	4 13
700	1 27	1600	4 40
800	1 43	1700	5 11
900	2 0	1800	5 49

These ranges of course vary with the powder charge.

Rapidity.—The following mean rapidity has been obtained by men at their first practice with the 1-in. torpedo battery gun:—

Four rounds at a time.	Relative rapidity per minute.
8 rounds in 1¼ secs.	384
20 ,, 6 ,,	200
40 ,, 12 ,,	200
100 ,, 58 ,,	104

Penetration of steel plates at ranges of—

1 English mile at right angles	$\frac{3}{16}$ in.
1500 yds. ,,	¼ ,,
200 ,, at 45°	½ ,,
200 ,, at 30°	¼ ,,
200 ,, at 20°	$\frac{3}{16}$,,
100 ,, at right angles	¾ ,,

Iron plates of about 33 p.c. greater thickness are penetrated at the same ranges and angles.

Ammunition.—Cartridge cases of solid drawn metal. Powder of somewhat larger grain than rifle powder of the weight of 625 grains. Bullets, sharp pointed, of hardened cast steel with gas check, or — envelope, 7¼ ozs. in weight.

Weight of Gun.	cwt.	qrs.	lb.
The gun itself	3	3	6
Marine gun carriage, consisting of (1) a pivot supporting wheel, screws, and bolts	0	2	25
Cross head (2)	1	1	2
Elevating screws (3), breech apparatus, and handle	0	1	12
7 bolts	0	3	0
	6	3	27

NOTE

ON THE

SERVICE OF THE ARTILLERY AT MAIWAND,

27th July, 1880,

BY

CAPT. N. P. FOWELL, R.A.

The principal things I observed connected with the artillery were—

(1) The great difficulty of keeping a supply of ammunition at the guns, on account of the labour involved in transferring it from the wagon bodies to the limbers, keeping the drivers hard at work as well as the Sergt.-Major, who is always of great service with the guns, especially if there are casualties among the officers. I would strongly advocate the system of limbers without bodies for carrying ammunition.

(2) The guns became so hot from rapid firing that we were unable to serve the vent without a protection for our thumbs. We had to pick up and use pieces of cartridge cases for this purpose. A conical plug of leather would obviate this, and also save one man when a detachment becomes shorthanded in action.

(3) I did not see nor hear of any driver making use of the pistol supplied to drivers in India. Had they stayed to use them, the guns might not have been brought out of action at all.

Many people think that Maclaine's guns were taken through his own fault in advancing so far to the front, but on the contrary, he had been recalled and had rejoined the rest of the battery long before; and if the battery had been ever so little in rear, instead of slightly in advance and in the centre of the line of infantry, I believe the line would never have been broken. But the guns were in action first, and then the infantry were brought up and placed in line rather in rear of us.

From the Revue d'Artillerie, Feb. 1881.

RÉSUMÉ OF AN ACCOUNT OF COMPARATIVE TRIALS OF THE NORDENFELT MITRAILLEUSE AND THE HOTCHKISS REVOLVER GUN CARRIED OUT IN ENGLAND, ITALY, DENMARK, RUSSIA, AND FRANCE.

BY

CAPT. A. E. TURNER, R.H.A.

The necessity of protecting ships from the enormously destructive effects of torpedo boats, has been the principal cause of the introduction of the above machine guns, and comparative trials of both have been carried out in the countries mentioned, with a view to ascertaining the respective merits and demerits of each on the following points:—

1st. Rapidity of the mechanism—that is to say the greatest number of unaimed shots that can be fired in a minute.

2nd. Real rapidity of firing—that is, the number of aimed shots which can be fired in a minute.

3rd. Precision.

4th. Precision, combined with rapidity.

5th. Facility of working, and durability of the mechanism.

England.—Trials were carried on at Portsmouth from March to May, 1880, on land, against targets and iron plates; at sea, against torpedo boats of the Thornycroft pattern.

It was found that the Nordenfelt mitrailleuse could be loaded and fired with much greater rapidity than the Hotchkiss gun, and that so long as the object fired at remained the same, its precision also was greater; but that this latter superiority is greatly lessened, when the range is subject to frequent change.

The penetration of the Nordenfelt ball is inferior to that of the Hotchkiss solid projectile with hardened head, but superior to that of the common shell.

For the experiments at sea, both the mitrailleuse and revolving gun

were mounted on board H. M. S. "Medway," and fired, while sailing at the rate of 8½ knots, at a torpedo boat of the Thornycroft pattern at anchor.

The mitrailleuse was again found to be superior both as to rapidity and accuracy; its mechanism moreover worked perfectly, while that of the cannon-revolver was somewhat damaged from the employment of a too rapidly burning powder.

A Nordenfelt mitrailleuse, calibre 25·4^{mm} (1 inch), whose projectile weighs 225 grammes (nearly 8 oz.) has therefore been adopted by the British Government.

Table of Experiments at sea.

	No. of shots.		No. of hits.		No. of shots per min.		No. of hits per min.		Per cent. of hits on rounds.		Remarks.
	Nordenfelt.	Hotchkiss.	Nordenfelt.	Hotchkiss.	Nordenfelt.	Hotchkiss.	Nordenfelt.	Hotchkiss.	Nordenfelt.	Hotchkiss.	
1st and 2nd course ...	118	52	62	11	23	11	12	2½	52	21	Fired at the beam of the torpedo boat, at ranges from 1500 to 500 yds.
3rd and 4th course ...	330	129	65	35	40	15½	8	4	20	25	
5th and 6th course ...	349	103	117	54	48½	12½	16	6½	33	52	Fired at the bows at the same ranges.
7th and 8th course ...	135	50	115	36	77	20½	66	14½	85	71	Do. from 500 to 100 yds.
Total	932	334	359	136							
Average					47	15	25½	7	47	42	

Italy.—Preliminary trials were carried out at Spezia in April, 1880, with much the same results as the above; the Hotchkiss mechanism however stood the test much better, owing to the employment of slower burning powder. Further experiments on a much larger scale were conducted in September and October, 1880, to determine the following points:—

1st. Penetration into iron and steel plates.

2nd. Initial velocity.

3rd. Rapidity of loading and firing at sea.

The steel Hotchkiss bullet with hardened head was found to possess greater penetration than the Nordenfelt bullet. The Hotchkiss shells burst after penetrating a short distance into the plate. The initial velocities were as follows:—

Hotchkiss steel bullet.....	375 mètres	...	410 yds.
Hotchkiss explosive shell	390 "	...	428 "
Nordenfelt projectile (reduced charge)	418 "	...	467 "
Nordenfelt projectile (full charge) ...	447 "	...	490 "

The rapidity of firing was in favour of the mitrailleuse, the accuracy slightly in favour of the revolving gun.

A great number of rounds were then fired to test the durability of the respective mechanisms. That of the revolving gun stood the test perfectly, but one of the needles of the mitrailleuse was broken off in the chamber, which caused a delay of half-an-hour.

Denmark.—The trials in this country showed that the balance of rapidity lay with the mitrailleuse, that of accuracy with the revolving gun. Both were fired from a gun boat at anchor, and also in motion, and a certain number of rounds were fired at night, by electric light. The averages of hits per minute at various ranges were—

Revolving gun	4·67
Mitrailleuse	3·98

The committee of experiments arrived at the following conclusions :—

1. The revolving gun is easier to work than the mitrailleuse, which requires three men; the latter can, however, be fired with greater rapidity, but the accuracy of the former is considerably greater.

2. The projectile of the revolving gun is heavier, and its explosive shell makes it much more formidable than the mitrailleuse against torpedo boats. Its mechanism is simple and more durable, it is easier mounted on board ship, and the nature of its construction would allow similar guns of much greater calibre to be manufactured.

Acting on the recommendation of the Committee, the Danish Government determined to adopt the Hotchkiss revolving gun.

In Russia experiments of like nature were carried out in September, 1879, the chief points to be ascertained being the comparative rapidity of fire, accuracy, and durability of the mechanism of both mitrailleuse and gun.

As in Denmark, the mitrailleuse was found to be more rapid, the revolving gun more accurate and far more durable; it was fired without interruption throughout the trials, while one of the transporters and two needles of the mitrailleuse were broken, which latter accident necessitated ceasing firing. A decision was therefore given in favour of the gun.

France has also adopted the Hotchkiss gun, in consequence of the result of experiments carried out in 1877, which were very similar to those of the Danish Government in 1879. The great advantage of its explosive projectile was much dwelt upon, it being not only capable of piercing the shell of a torpedo boat, but also of inflicting severe loss on the crew, as it breaks up on an average into 19 pieces.

All the above powers have pronounced that both these machine guns are adapted for the efficacious protection of ships at close quarters.

England has adopted the Nordenfelt mitrailleuse; some powers have ordered a supply of both. France, Russia, Holland, Denmark, and Greece have pronounced in favour of the revolving gun for naval

purposes, while Germany, as will be seen from the following extract from the *Militär-Wochenblatt*, 22nd January, 1881, has followed their example:—

"An imperial order dated 11th January, 1881, has prescribed the introduction of the Hotchkiss revolving gun into the German navy. All ships of war will carry a sufficient number of these guns, so that every point within a range of 200 yds. may be simultaneously swept by the fire of at least two of them."

AUSTRIA.—TRIAL OF A REPEATING RIFLE.

On the 4th January, 1881, trial was made at Vienna of the Falmisberg repeating rifle. The repeating arrangement, which is very simple, can be easily adapted to the Gras rifle in use in the service; it was found to act perfectly, and eight shots were fired in five seconds. Further trials will take place.

Use of Dynamoge.—By order of the War Minister, trials have been made at the arsenal of a detonating composition invented by Mr. F. J. Petry, a civil engineer, and called by him Dynamoge, with the following results: Initial velocity with dynamoge 323·9 mètres to 356·3 mètres, against 295·6 mètres to 302·2 mètres with gunpowder. The firing with the latter was more accurate, but this was partly attributed to want of confidence in the men using the new composition. In both cases the bulk of the cartridge is the same. 50 rounds were fired with great rapidity, when it was found that while the barrel of the rifle fired with gunpowder was so hot that it could no longer be used for a time, that fired with dynamoge was but little heated. The former rifle was very foul after the trial, while the dynamoge left so little residue that a piece of rag once passed through the barrel was sufficient to clean it. There was but little flash and smoke from its discharge.

ALDERSHOT,
13th March, 1881.

EXTRACTS

FROM THE

DIARY OF A RUSSIAN ARTILLERYMAN IN THE SHIPKA PASS, 1877.

From the Russian,

BY

LIEUT. J. M. GRIERSON, R. A.

The 2nd Battery of the 9th Brigade, which had held the position of Mount St. Nicholas in the first half of August, and had been engaged in the hard fighting of the 9th, 10th, 11th and 12th of that month, became at length so enfeebled by heavy losses in matériel and men (about 50 killed and wounded, leaving hardly enough to serve the guns), that it had to be relieved by another battery. In consequence of the considerable number of rounds (about 5000) fired by the battery, out of eight guns only three remained fit for service; of the others, two were so seriously damaged by the enemy's fire that it was impossible to use them, and the other three were rendered unserviceable by the scoring of the powder gases during the quick and powerful fire necessary to repulse the repeated attacks of those days.

Replacing one battery by another was doubtless unfavourable for the defence. It was, however, decided by the consideration that it was better to have an intact battery in an important position, than one which, although its worth and steadiness had been proved in battles second to none in the war of 1877 - 78, had suffered so severely.

In the first days of the defence the artillery had rendered most important services. In general it had completely prevented the enemy's masses from moving close up to our position to support the attack, and when these onsets were repulsed, it shattered the defensive positions which the enemy tried to maintain on the ground he had won. Having forced the enemy to withdraw from his advanced positions, and to act on the active-defensive, our artillery had now to sustain a duel with that of the enemy. The defence of the pass was conducted on the passive-defensive, for which artillery is the most important arm, while the works were being strengthened and added to.

The precision of our 4-pr. guns was remarkable. Their effect on troops at the longer ranges (up to 1200 *sagenes*) was satisfactory, but the same could not be said of the working of their breech mechanism. From the experience of the war, all were convinced of the superior utility of our heavier field guns. General praise was awarded to the 9-pr. guns, which were much preferred to the 4-prs. Therefore for the more important batteries it was decided to use 9-pr. guns, while the

4-prs. were used for the secondary positions. It was also found necessary to increase the number of batteries on Mount St. Nicholas, and to construct stronger works.

The latter was a work of the first necessity. In the first days of the defence, while the fighting was going on, the guns fired over the parapet. This was necessary, as the guns had to fire on troops which attacked them on all sides, and was of great service, as it afforded a wider lateral range, which was necessitated by the frequent changes of position made by the attacking troops. This advantage, however, was counterbalanced by the great exposure of the gun detachments to the enemy's rifle fire, and still more by their exposure to that of his artillery. Under these circumstances it was found necessary to place the guns behind embrasures. To each battery was now told off a definite object, one of the enemy's positions.

With the appearance of the enemy's artillery the necessity arose of strengthening the profile of the works. The first hastily thrown-up field works now began to assume the appearance of permanent batteries. The works were carefully planned and defiladed from the enemies batteries and everything prepared for a passive defence.

Such was the state of affairs on Mount St. Nicholas when we learned that our battery was to relieve the 2nd. According to the orders of the O. C. the Artillery of the Corps, one 9-pr. battery was to be furnished by each brigade (9th and 14th) for Mount St. Nicholas, and one 4-pr. battery by the 14th Brigade, for the "Circular Battery." The choice of the batteries was left to the officers commanding Brigades. On the 19th August, the 1st Battery, 9th Brigade, received orders from the O. C. the Artillery of the Corps to proceed to Mount St. Nicholas, and relieve the 2nd Battery of the same Brigade.

We lay in bivouac on the north side of Gabrova, so to reach St. Nicholas towards night we had to start at 4 p.m. at the latest. Usually all cooked food and the reinforcements arrived at St. Nicholas when it began to get dark, but often all communication between the "Red Houses" and St. Nicholas was interrupted by the enemy's fire from the "wooded bridge," which they held for this purpose. The long ascent of the pass therefore obliged us to start long before evening.

At that time the battery consisted of 4 guns and 12 ammunition wagons. Two guns had already been in the position since the 14th, and two others had been given over to the 14th Brigade, to replace two of their guns which had been damaged by the enemy's fire*. Some of the wagons were, with the guns, already in position, and some had been handed over to the 2nd Battery. But the 12 we had with us were quite sufficient at first, besides, the relieved battery was to leave its wagons for the use of the relieving one. This afterwards became the rule in the Shipka. It was done for the purpose of lightening the task of the relieving battery in bringing up its wagons. Finally, if the number of rounds in the 12 wagons was insufficient, the battery

* The exchange of guns between the batteries of an army corps took place on the order of the O. C. Artillery; if the guns of one brigade, which was likely to be heavily engaged, had been damaged, they were replaced by those of the other.

was to draw on the 15th Field Park, which for this purpose had been moved up to the foot of the Pass. The incomplete state of the battery had, however, this advantage, that the horses of the 4 guns and 12 wagons, which had been detached, could be used to increase the teams of the remaining carriages, and this was a necessity, as the ordinary teams were unable to pull the heavy wagons up the steep road. Each team was therefore increased by one pair of horses.

The weather was favourable, being dry and warm. The former circumstance made the ascent easier, the second enabled the men to be lightly clothed and to leave behind their heavy baggage. Although at this time almost everybody went about in bivouac in blouses, in the position all had to wear cloth uniform, as the white jackets offered too good an aim to the enemy's sharpshooters.

At 3 p.m., the battery was collected at the entrance to the Pass. The extra pair of horses were hooked into each carriage, the men each carried both pairs of boots, some clean underclothing, and their rations. The commander gave out orders as to the supply of food to be sent up, and as to the reports, &c., to be rendered. The baggage was left in charge of the sergeant-major, as all the three effective officers had to accompany the battery.

After a short divine service the battery advanced into the Pass. In the Shipka for the first time! Through all our minds passed the thought, "Shall I ever return again!" But we did not long nourish such gloomy ideas. Hardly had we been a quarter of an hour on the road when all began to talk of how soon we should arrive on the position, if we should arrive in the night or at dawn, where a halt would be made, &c.; all busied themselves with the present, and left the future to take care of itself.

The narrow streets of Gabrova offered great hindrances to our advance. An ox cart got in our way and it was impossible to pass it by. Our lads, however, soon hustled it into a side street, and at last we debouched on the high road, after great difficulties in getting round the sharp corners. The road we took led first along the valley of a mountain stream, and for a short distance was paved. Then a bad bit had to be traversed, but towards the foot of the ascent it became good again, although the frequent traffic of heavy carriages had cut it up a good deal, and deep holes and heaps of stones were encountered the whole way. In three places the road crosses the stream by bridges, but, as in the whole of Turkey, they were built in the form of an arc, and were so steep that at one side one could not see if anyone was at the other end of the bridge. The passage of such bridges was rendered so difficult and dangerous by their narrowness ($1\frac{1}{2}$ *sagenes*) and the absence of hand-rails that we preferred, where possible, to ford the river. By this valley it was five *versts* to the foot of the Pass, and at the end of it the battery halted for a short rest. Here the wagons were formed into a separate échelon, and the guns sent on in front, so that the former might not hinder the quicker advance of the latter.

The so-called "first ascent," is the most difficult in the whole Pass. There is a slope of about 15°, 20 *sagenes* long, then the road turns

suddenly to the left, becomes narrow, and at a second bend to the right rises gradually up the slope of a considerable mountain for a *verst*, with a deep wooded gully on the right. The guns went up one by one, the teams were put into their collars, and our good horses, urged to a gallop by the cries of their drivers, easily drew the guns up the slope, and then went along the short level at a quiet walk; a distance of 10 *sagenes* was kept between each gun. We had more trouble with the wagons, and the detachments had to push behind to help the horses, while the carriages, constantly stopping, had often to be scotched up with stones.

The guns had got a long way ahead when we got the last wagon up, but the most difficult part of the march was over, as there were no more such ascents, and the road rose very gradually. For half a *verst* the road was level, but rose again, though slightly, in the next *verst*. Before reaching this latter rise, we halted to rest the men and horses. The sun had not yet gone down, so to profit by the light we soon moved on again in the same order as before. The men, who had left their packs behind, marched with ease, but the horses soon began to show signs of exhaustion. The road now ran along a terrace, and turned to the right along a ridge with a deep valley on both sides. Hitherto the road had been comparatively deserted, but we now began to meet military carts coming down filled with sick and wounded, Bulgarians with their asses or oxen, and Cossacks going down to Gabrova. Then the road grew pretty level, and we found ourselves in front of the Corps Commander. Here were bivouacked sappers, riflemen, the ammunition park, and the field hospital, on a broad part of the ridge. Taking advantage of an open space, we here formed up the guns, watered and fed, and awaited the arrival of the wagons, which appeared sooner than we expected.

We remained halted till sundown, and at 7 p.m., started again on a most difficult road. At the telegraph station (a *verst* from the head quarter camp) the road again ran up a steep ascent. The guns got up it, but the wagons stuck. The road gradually bore off to the left and at a steep rock, at the foot of which was pitched the tent of the Corps Artillery Commander, it made an abrupt turn in that direction. This officer came out to meet us and gave us directions as to our further advance. Up to this point we knew the road; on the 16th the battery had moved thus far up the Pass, but here had received the order, "To send one division, with its wagons, up to the position, and to return with the rest of the battery to the bivouac at Gabrova, and remain at the disposal of the Commander of the Corps Artillery."

Here, on a small plain, was the second bandaging station. The repressed groans and cries shewed us that we had already entered the position, and wounded men coming down the road said that Mount St. Nicholas was not far off. It began to grow dark. By the twilight we could see the mountain standing out from the dark mass of surrounding hills. We soon had to halt again to close up the guns. The ascent became steeper and steeper, and finally reached a plain on which was bivouacked a sapper battalion. Here the road turned sharply to the

right; a *verst* further on we reached the hamlet* occupied by the staff of the Briansk regiment, then, passing through a ravine, arrived at the foot of the two hills occupied by the 5th, 6th, and Round batteries.

Here began the line of our lodgments. The infantry lining these trenches acted as covering parties for the batteries, the said lodgments being mere shelter trenches for one or two companies, some of them provided with cover from vertical fire. On the parapet of these trenches the rifles lay close together, so that at the first alarm a heavy fire might be opened. We soon reached the "Red Hamlet," where a bandaging station had at first been established, but they were now occupied by the staffs of the Jitonier and Vollugnian regiments, and by a collecting station for slightly wounded men.

From here the road, bending to the left, crossed a neck of land commanded throughout by the woody mountain. The right slope of the neck was swept by the fire of the trenches near the "Red Hamlet," occupied by the Vollugnian regiment. The left slope, between the St. Nicholas and another hill, descends into a deep narrow gully covered with pine woods, which is swept by the fire of the circular battery. This fire could not reach the bottom of the ravine, on account of the great angle of depression, but defended the entrance into it from the Turkish side. The road kept gradually bearing off to the left after passing the neck, when it reached a level plateau, and began the ascent of Mount St. Nicholas, the extreme south point of the position from its left rear.

At 10 p.m. we reached the summit of the mountain, halted on the road and unhooked, as the guns had to be run into the battery by hand. The work was accomplished with the greatest quietness; there were neither noises nor cries, and all commands were given in a low voice: never had arrangements been made so perfectly, and never had they been executed with such exactitude as in this operation. All understood that a wrongly given order, a fault in execution, or the slightest carelessness, might lead to most serious consequence, and that a delay or want of punctuality might spoil the whole affair. We felt the proximity of the enemy. The relief had to be so arranged that the battery might be ready to open fire at any instant, and the guns were therefore withdrawn one by one, each piece being brought up close to the corresponding one already in the battery, which was then withdrawn, the new gun taking its place. Having put his gun in position, the No. 1 was informed by the No. 1 of the relieved battery how and when to fire, with what nature of ammunition, the height of the object, the necessary deflection, &c., all of which he was required to note down. The places from which wood and water were to be drawn were also pointed out, as well as other minor details. On their side, the officers learned from those of the 2nd Battery all the data necessary for the conduct of the firing.

Within an hour all our guns were put in position, and those of the 2nd Battery were started on their march down the mountain, horsed partly by their own, partly by our animals. Some of their ammunition

---

* The Turkish Custom House.

wagons were left for our use to avoid unnecessary displacements, and the rest were taken to Gabrova. At first it was decided to leave the limbers and wagons at the side of the road on the slope of the hill, but this disposition was afterwards changed. In the first days of the defence, they had been left on the slope not far from the battery. To bring them up to the top of the hill was almost impossible as the road was of the worst description, but they managed to get some of them under cover in a small ravine on the north-east side of the hill. Afterwards the road was improved, and the wagons, &c., were easily brought half-way up that part of Mount St. Nicholas which rises above the road. Here there was not room however for all of them, and a number had to be left by the roadside on the north slope, where they were completely exposed to the enemy's fire.

For all this exposed position, the limbers and wagons were not hit by one-tenth part of the bullets and shells fired at them. Although no serious damage was done, it was considered best to remove them to avoid the danger of losing all by the bursting of one. Actually on the 10th August a well directed shell set one of the wagons on fire, and threatened us with the loss of all the carriages which were standing closely packed together for want of room, but, thanks to the bravery of some of the men, who, at the risk of their lives, succeeded in rolling it down the hill, and extinguishing the flames, it did not burst; the shells and cartridges were taken out, and the wagon, seriously damaged by fire, which was extinguished by throwing earth on it, was broken up. Afterwards part of the wagons were brought up (on the improved path) to the summit of St. Nicholas, and were placed in the ravine along the top of the northern slope; the remaining four limbers and two wagons were left in the open, two *sagenes* from one another. These were to be held as a reserve in case ammunition ran short in the battery, but it would have been almost impossible to bring stores up from them under the hail of projectiles poured on St. Nicholas from all sides during the the fighting.

Warned by the incident of the burning wagon of the 2nd Battery, our Commander decided to keep neither wagons nor limbers near the battery, but ordered all the cartridges, four common and seven shrapnel, and all the case shot to be brought up from each wagon, to be divided equally amongst the guns, and to be placed in magazines cut in and below the parapet of the battery, so that each gun had at hand 10 common, 10 shrapnel, and 4 case. All our wagons and limbers were placed in the above-mentioned ravine. There, of course, they were not quite of harm's way, but it was much better than having them close to the battery, which, although it would have given us a greater number of rounds at hand, might have caused the loss of all by the bursting of a single wagon.

Four limbers and six wagons were therefore brought up and placed in the ravine, with their poles and shafts resting on the slope, and $1\frac{1}{2}$ *sagenes* apart. The wagons left by the 2nd Battery were placed two *sagenes* behind, and covering ours. They were thus somewhat crowded, but if we had placed them farther apart some would have been exposed, as on the right the ravine terminated, and on the left it fell into a deep

rugged valley, in which, later on (in September) two sunken 6-inch mortar batteries were built to fire against the "Devyatiglazka" Battery. As it was, their position was very favourable. In front they were protected by the hill itself, in rear by an old Turkish breastwork, on the right by another half demolished Turkish entrenchment, and on the left again by the hill. Pits were, however, dug for the wheels, in case the wagons might be seen from the "Woody Hill," or from the "Devyatiglazka" Battery. This ravine, it seemed, was regarded by the Turks as the least exposed part of the position, for, during their occupation of the Pass, they had here constructed a magazine for all the artillery of the defence. This was built behind the first named breastwork, which mounted several guns, destined to sweep the Gabrova road and the approaches to Mount St. Nicholas from the north.

The magazine was almost finished, and had been skilfully and carefully constructed. Its position on the slope made it almost invisible to anyone in the valley, and the approach to it was protected by a slight parapet 3½ feet high; it held enough shells, cartridges, and other stores to suffice for all our needs when we first occupied the Pass. The stores were used up by the commander of the "Steel Battery." Sub-Lieutenant K., "annexed" the magazine with this intention, but afterwards it was put in charge of one of the officers of Battery No. 1, and when all the rounds it contained were fired away, it was used as a shelter for the drivers. In September it was badly damaged by the enemy's shells, and was then abandoned.

All the spare rounds were taken over from the 2nd Battery, the empty wagons were taken away so as not to take up room, and all superfluous stores were sent down to Gabrova. At about midnight the whole work was finished, and the men settled down in the lodgments, close to their guns. Sentries were posted, whose duty it was to wake the men in case of necessity, and each gun was laid by means of scales, to regulate the firing in case of an unexpected attack. An officer was was placed on duty in the battery for the whole night, who had to remain in it to give the alarm in case of necessity, and to visit the sentries (of the infantry). All other officers had to be in readiness to turn out at the first alarm. The commander of the battery and two other officers occupied one tent; two of ours, one of the 2nd Battery (who was attached to us for duty), and the commander of the "Steel Battery," shared another. The latter tent was a double Turkish horsehair one, and proved very good. The former was pitched over a hole two feet deep, seven broad, and twelve long, and was made up of two soldiers tents joined together. In the centre the earth had been left so as to form a table, but this had the disadvantage of limiting the interior space. In the corners of the excavation the sleeping places were arranged in slight hollows. Both tents were pitched behind the Turkish breastwork to the left rear of the battery, and were completely screened from the enemy's sight, except from the batteries on the "Woody Hill," which was, however, pretty far off.

At about 2 a.m. we turned in, forgetting Shipka and the Turks, and everything else in our wearied state.

20th August. The enemy, however, did not let us oversleep ourselves,

at 8 a.m. the cannonade opened from almost all the batteries except the "Devyatiglazka." We were soon all in our places and received orders from the commander of the battery to commence firing slowly from the right. The practice against "Devyatiglazka" was conducted with an elevation of 36 lines, and the guns were laid on the two central embrasures, which were the most visible. It is impossible to say that the first results were satisfactory. The Nos. 1 lost their presence of mind and began to diminish the elevation sometimes by as much as two lines, frequently forgetting to give the necessary tabular deflection; and this loss of coolness increased in a rapidly ascending scale so as to seriously interfere with the laying. In one of the guns of the 4th division the laying took a particularly long time. In the first place the gun was not level, and then the line of fire was not perpendicular to the parapet, so it had to be got into position by handspikes. Then the flurried state of the loading number retarded the work; when at the handspike he was constantly throwing the trail too much to the right or left, and so the laying was lengthened out, and the No. 1's eye got tired. This went on till another number, a cooler hand, volunteered to take his place. Our first shot was from the right gun where the commander of the battery had taken up his position. The curiosity of all was so strong that the whole detachment rushed to the embrasure to see where the shell burst and some even jumped on the parapet. This shell fell short and did no damage, although the look-out men said it was well placed. The crowd of observers was however soon scattered by a few dozen rifle balls which the watchful Turkish sharpshooters let fly at us from a flank lodgment, of which one knocked off the cap of a look-out man, who shewed himself more than was necessary.

After the second round from the battery, "Devyatiglazka" fired a salvo at us which effectually stopped the men from running to see the effect of our shells. All the enemy's shells burst in the *parados,* two *sagenes* behind our guns. The men ran from their guns and crowded against the lateral traverses. But an answer was soon given to this salvo from the "steel battery," then from our 5th gun, and after that all went on as usual. Seeing that the enemy's shells were not so dangerous as they were said to be, the men soon cooled down and stood steadily to their guns, the loading was carried out more carefully, and the laying more quickly. The only thing that bothered us was the recoil. Although a traverse ran along behind the gun to check the recoil, this latter was still very great, and although we scotched up the wheels with handspikes, the shock often damaged the traverse seriously; we had also to remove the trail handspike.

The running-up of the guns was done even quicker than at drill; the men knew that if a shell fell in the embrasure at the moment of running-up, the detachment would suffer severely, therefore they ran up the gun as quickly as possible, and took shelter behind traverses, or the main parapet, till the order to load was given actually. After our third round, two shells struck the embrasure, considerably damaged its right cheek, and covered us all with mud and stones, but the splinters lodged in the parapet and caused no loss. At the bursting of these

shells such a smell of sulphur arose that the men of No. 5 gun all began to cough as if they had smelt something poisonous. The enemy continued to fire salvoes but did us little or no harm. Many of his shells, missing the parapet, lodged in the *parados*, and did not burst, and others burst in the air, sending their splinters to our rear. Some damage was, however, done to the parapet and embrasures.

We went on firing slowly, except when the enemy's fire slackened, when we fired salvoes by divisions; by one fired by the 4th Division, two embrasures, the centre one, and the one from the right of "Devyatiglazka" were much damaged. Towards the end of the firing our men became so cool that they made jokes and criticisms on our own and the enemy's shells.

At about 11 o'clock the firing ceased all along the line, except that of the small arms, which kept up a lively rattle, broken at rare intervals by the boom of a heavy gun. To the whistling of the bullets we paid hardly any attention; many did not even hear them, so deafened were they by the previous artillery duel, and we had to shout at one another to be heard at all. As the enemy had evidently no wish to prolong the firing, the order was given to load all the guns with common shell and lay them on the third embrasure from the left of "Devyatiglazka." The men lay down and we went into our tents. Soon the order was given to unload, sponge and wash out the guns, and load and lay again; and while the men rested and boiled their tea we also refreshed ourselves, and discussed the results of the firing of the day and the means of strengthening the battery. If all the counsels, opinions, and advice then given had been acted upon, our firing would, of course, been irreproachable, and we should have knocked "Dvygatiglazka" into a "cocked hat!" However, it was not the first time a battery had not made splendid practice, but now that the firing was over we all forgot how far we were from being able to call ourselves good shots. Above all, we agreed that it was necessary to increase the height of the parapet on the flank on which it was exposed to the enfilade fire from the Turkish lodgments, as the bullets from them, flying over the parapet, fell into the battery, and although, as yet, they had caused us no loss, they discomposed the men. Besides, an embrasure existed in this parapet which we had not armed and did not require, and through which the Turkish skirmishers constantly fired. This we thought advisable to build up, but the commander of the battery decided that for the present it should be only blinded, so that in case of need we might fire from it on the hostile lodgments.

During the action we had observed that the embrasures were getting damaged by our own firing. This arose from their exterior and interior dimensions being smaller than usual, and they had been so constructed to present a smaller aim to the enemy's projectiles. At first the object had been at right angles to the line of fire passing through the axis of the embrasure, but these lines of fire were not perpendicular to "Devyatiglazka," but to the lodgments which had been built lower down, and the actual line of fire therefore made an acute angle with that for which the embrasure had been constructed. This, of course, caused one cheek of the embrasure to be much more affected by the

discharge than the other. To avoid total destruction of the embrasures we resolved to revet them with gabions and fascines, changing the axis of the embrasures, but keeping the same dimensions as before. Revetting with gabions also had the advantage of diminishing the number of stones thrown up by the bursting of the enemy's projectiles in the embrasures, and therefore the probability of wounds and bruises to the men. These had done damage enough already, some had been thrown into the bores of the guns, and others had cut the men very severely about the face and hands.

During the firing we also noticed that the trail tore up the ground very much in its recoil. To remedy this serious inconvenience, one of our officers, Lieut. B., proposed to place broad flagstones under the trail, such as were to be found in great numbers in rear of the battery on the stony slopes of Mount St. Nicholas. The force of recoil was a great hindrance to the firing, sometimes the trail would penetrate so far into the rear traverse, that it required the united efforts of the whole detachment to move the carriage forwards, but without this rear traverse it was worse. The gun recoiled almost as far as on a perfectly horizontal surface, and that made it most dangerous for the gunners who had to leave cover to run it up again, and thus exposed themselves to the fire from the Turkish trenches in front and on the flanks. To move the traverse further back would have increased the interior space in the battery, but would have offered a better mark to the enemy, and the primary *raison d'être* of the traverse, to limit the recoil, would have been lost. We therefore determined to leave the traverse in its present position, and to revet it on the inside with gabions and fascines, to break the shock of the recoil, and to prevent the trail from digging in. The terreplein was also to be cut down in a slope towards the parapet, the soles of the embrasures lowered, and their exterior dimensions increased, which measures permitted of our sweeping the slope of the hill in front, and diminishing the dead angle.

Each gun was separated from the one next to it by a traverse, which joined the parapet at the same height, and was one foot lower in rear. The full of the superior crest of these traverses permitted of an officer standing in rear of them, and at the same time watching the effect of the shot and superintending his two guns. For general purposes of observation steps were cut in the rear traverse (*parados*), standing on which an observer could see "Devyatiglazka" over the crest of the parapet. The officers standing at the rear of the traverse, were, however very much exposed to the enemy's fire, and to avoid this a gabion was placed at the rear of every traverse to protect the observer from bullets, &c., from the right, while a fascine was laid along the top of the traverse, projecting over its rear end, to protect his head from those from the left, and steps were cut in the rear to enable him to ascend and descend.

It was also decided to build blindages for the men, and this subject was brought before an officer of sappers, whose duty it was to carry out repairs in the battery under the orders of the officer commanding. But all our projected improvements and repairs could not be carried out in one day, so the most important had to be first taken in hand,

and we began to prepare the cheeks of the embrasures for revetment, and place flat stones below the trails for the whole length of the recoil. Darkness coming on at 8 p.m. would protect the execution of the works, and at that time the sappers would arrive with the materials which they had got ready in their bivouac behind the "Round Battery" in the course of the day.

Till darkness set in we had lots of spare time. After such excitement it was impossible to sleep, and we began to talk of the Turks, of Mount St. Nicholas, of the killed and wounded. Some one had got hold of the "Journal of the Fatherland," and was reading it aloud. Mens feelings were aroused, and involuntarily they crowded round him; in our tent it was suffocating, and therefore we all got out of it, and lay down by the entrance. Every minute the bullets whistled over our heads, singing in different keys. From time to time the sharp crack of the Berdan, No. 1, was heard behind our tents from the trenches of the rifles. Soon some of the rifle officers came to have a chat with us about the shooting. They assured us that the men rarely answered the Turkish fire as they had orders to spare their cartridges. They described to us how the firing was carried on. Each group (six men) chose from themselves one man, whose duty it was to look out and fire at the enemy when one shewed himself. This, however, the Turks seldom did, and all that one man could do was to aim at the clouds of smoke. The rifle was therefore loaded and laid on the parapet; the riflemen remained ready to fire, keeping his eye on the enemy's trenches, and whenever he saw a puff of smoke, at once fired. Sometimes they tried another way, they let the enemy fire two or three times without answering, to induce him to shew himself, and at the fourth shot fired at once. The Turks, however, soon understood all these dodges, and began to change their places after every shot, and this they did so cleverly, that our men saw it was of no use to fire at the smoke, and so answered the shots very rarely. Sometimes a group of our men would all fire at once, but they were invariably answered by a salvo which generally reduced their numbers a little. They therefore deepened the cutting in which their rifles were placed so that their heads might be protected, and fired as through embrasures. At this time the covering party of our battery was found by two companies of the 15th Rifle Battalion. They were placed to the front and flank of the battery, and had orders to sweep with their fire the valley between Mount St. Nicholas and the hill on which stood "Devyatiglazka." Thus placed, they swept the approaches to the battery and the dead angle in front of it, not touched by our own fire.

While we were chatting with the rifle officers, the commander wrote a report on the day's firing. It ran as follows:—"To day, the 20th, Battery No. 1 fired at the Turkish nine-gun battery, and by two well placed shots destroyed two of its embrasures. There were no losses in men in the 1st battery, or in the 'Steel Battery,' but the division of the 2nd battery lost one sergeant killed. There were no losses in matériel in the 1st or 'Steel Batteries,' in the division of the 2nd battery, an elevating screw was damaged. 66 common shell, or 11 per gun were fired by the 1st battery. The 'Steel Battery' was

only in action for a very short time, 'for want of ammunition." This report was at once sent off to the commander, the Colonel of the Podolsk Regiment. To it was added a requisition for sappers, with the necessary tools and materials, to be sent up that night to repair damages. Copies of the report were sent to the Commander of the Artillery of the Corps, to the Commander of the troops in the Shipka Pass, and to the Commander of the Brigade.

As the enemy could easily see into the battery through the two right flank embrasures, we took the guns out of them and closed up the right one with gabions, forming a blindage in that angle of the battery. We replaced the men of the 2nd Battery, serving their gun by our own from the reserve, and at night sent the damaged gun of the 2nd Battery with both the detachments and the horses of that battery down to Gabrova by the high road.

We now went to look round the battery. The men were mostly in the blindages, and talking of the day's firing. From one blindage rose a mournful song, from another noise, cries, and laughter, in another a newspaper was being spelt out. Everything was going on in this exposed position as if we had been in a quiet camp or bivouac. We looked round the guns and found them as clean as might be expected. They had all been loaded and run up, so we did not make a detailed inspection. We never had any fault to find with the way in which the guns were taken care of after firing. The men cleaned them not because they were ordered, but because they were fully convinced of the necessity of keeping the guns in good order. They had had it instilled into them how much the slightest inaccuracy affects the firing, and that there had been cases in which, when a gun had not been properly cleaned and rust allowed to form, three men could not force the projectile home. From personal experience, each man knew that the cleaner his gun was, the quicker he could fire, as it made the constant washing out of the bore easier. After the sponge had been dipped 10 or 15 times in the bucket, the water became so dirty that it only dirtied the bore more to sponge it out, so the water had to be poured out and renewed. But fresh water had to be carried about a *verst* under the fire of an enemy who always shot at any man showing himself on the road on Mount St. Nicholas, or behind Battery No. 1, so to have water enough at hand, it was brought up in large pails from the spring, and the gun buckets were replenished, when necessary, by this means. *Apropos* of sponging out, a little incident is worth mentioning. In his anxiety to sponge out smartly, one of the men jammed the sponge so tightly into a bucket that it was pulled out with difficulty. It was a sight to see the fright and sorry position of the man, as spreading out his hands he turned to the detachment, who were cursing his clumsiness, and said :—"Just my d—d luck; many a year have I handled a sponge, and that never before happened; however, here goes!" This sally, pronounced in disgust at his own awkwardness, called forth a burst of laughing. At that minute a shell went slap into the next embrasure on the right, and a whole volley of jokes, witticisms, and fun burst from the detachment, showing their perfect coolness. When the firing began, this same man

had been very much excited, but for the rest of the time he kept the whole detachment in good humour with his quaint sayings.

Little by little the rattle of small arms grew fainter, and towards 6 o'clock only a few shots were fired by the enemy. The sun began to go down, and it grew cold. About 8 darkness set in and we were free to stroll about on Mount St. Nicholas, which only those who were forced to move about dared do in the daytime. Now, however, when the firing ceased, a sudden mania for walking about seemed to seize on everyone, and the talking, which had been almost suppressed all day, now grew louder. The men went to fetch wood and water, and to wait for the cooked food which was to be brought up the high road, not far from the battery, and which was to serve for supper that day, and breakfast the next. Brandy was also to be brought up. As our horses were in Gabrova, the kitchen was also established there, and there our food was cooked before bringing it up. Everything has to be ready by 3 p.m., and at that hour the sergeant-major, who had remained to look after the horses, got everything ready for a start. Six of our horses were hooked into the sutler's wagon, in which the kettles with the food were closely packed and tied together with ropes. Spirit cases were also put in, and the cook on duty had to take some wood with him to heat up the kettles when the cart halted at the "Red hamlet," to give the horses a rest before ascending the Pass. The food consisted of *schtchi* (cabbage soup) 1½ pounds of beef, and gruel.

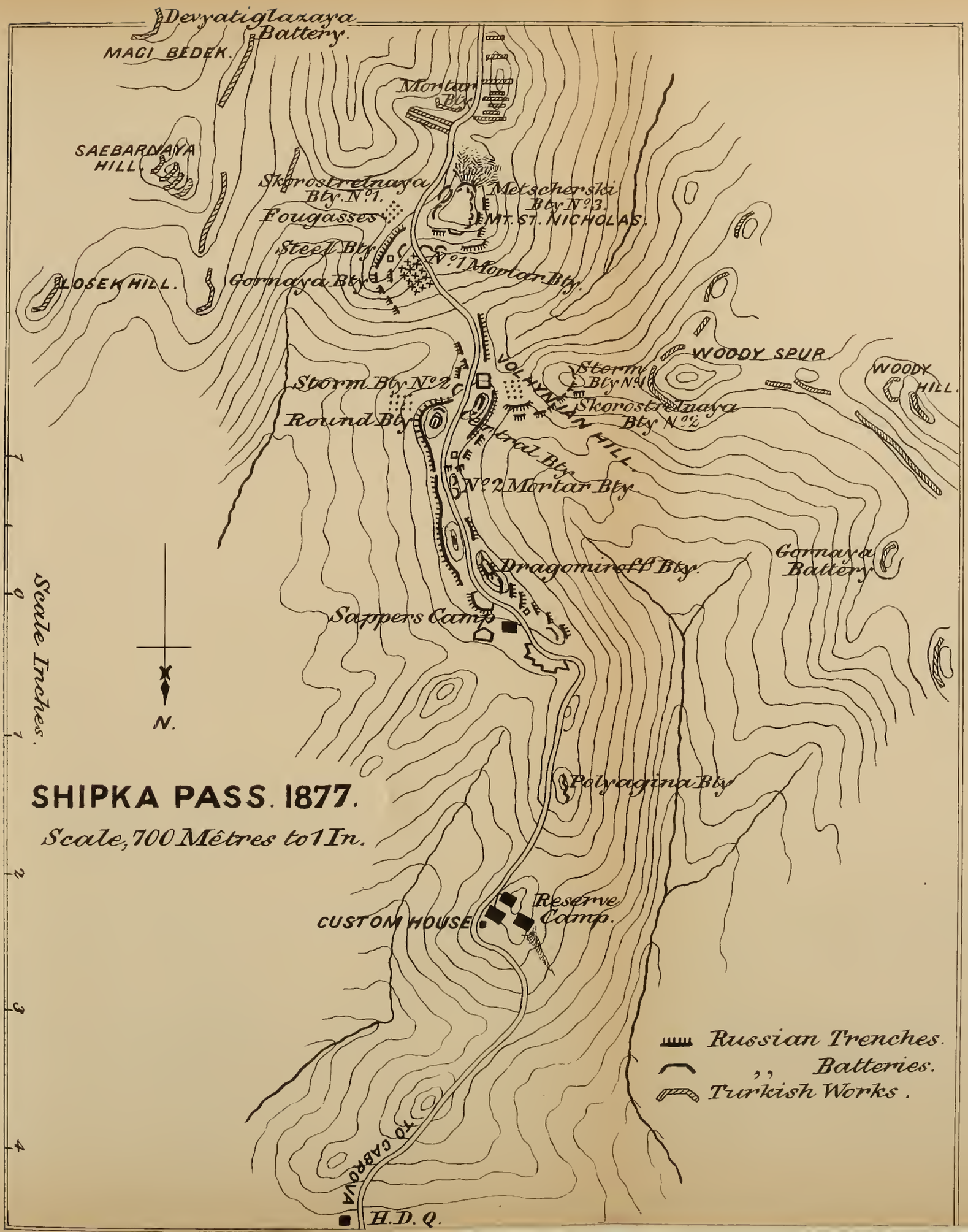
This increase of the ration of meat had been ordered by the Army Headquarters, but due praise must be given to the subordinate commanders, who displayed the greatest solicitude in seeing their men well fed. As regards the artillery, many and many a time did our men bless the commander who took such good care of them. The tea ration remained the same, but that of brandy was increased, and our men preferred tinned meats to their ordinary rations. In the morning a large can of ordinary tea was served out with two pieces of sugar, at midday two glasses of good Russian brandy, and at night the entire rations with half a glass of brandy, with a breakfast of tinned meat of great nourishing power for next morning. The infantry used to begrudge our men their better food, and say that our fellows lived like princes, and that all should fare alike. But our commanders were better able to supply good food, as they had considerable means in hand, saved on the messing in time of peace, which amply sufficed to buy the necessaries, and which were also laid out in purchasing extra cattle.

At 8 o'clock the cooked food arrived at the "Red Hamlet," where it usually remained till darkness sat in, when the isthmus could be crossed with less danger, although many a time the Turks fired on it from the Woody Hill, and under favourable circumstances it would be generally brought up close under the summit of Mount St. Nicholas by the road. Hearing the noise of the wheels the Turks often fired a volley at random, and sometimes killed or wounded a horse or man, but such cases were rare. Along with the mens rations our own dinners were brought up, part of which we reserved for breakfast. The proper arrival of the rations was an important thing for the men. In the first

place, good physical condition entails good moral condition, and a full soldier and a fasting soldier are two very different beings and are of very different temperaments. Four-fifths of a soldier's courage is physical, and the rest moral, and therefore it is of most importance to keep up his physical strength. In the second place, some tidings of what was going on elsewhere was usually brought up with the rations; often some papers, the *Russian Invalid* or the *Tetuchine Listok*, or some others were sent by the careful hand of some staff officer. In the third place, some articles of clothing were also often sent up which were in great request, both for officers and men. Presents were also often sent to the defenders of the Shipka, and those that were most appreciated by the men were boots and tobacco, the former most necessary articles. The latter, the soldiers greatest comfort, becomes almost indispensable to him on active service. The days on which those good things arrived were kept almost as holidays on Mount St. Nicholas. We used often to order for our men cheap Bulgarian tobacco, but they thought it far inferior to Russian "*jilka*" or "*machorka*." Often and often the infantrymen used to come to our fellows and ask to buy the Bulgarian tobacco, but here the good side of our men came out, and they insisted on their less fortunate comrades sharing their "*jilka*," and many will remember having asked soldiers :—"What do you want still, you have enough to eat and drink, your boots and clothing are good, and the brandy is still to the fore," and having received the answer :—"All that is nothing Highness, without tobacco!" Tobacco was the only luxury they craved after, a pipe after their morning cup of tea.

After dinner the men lay down to snatch a little rest till the sappers came at 4 o'clock, when the work began. There were six of them, and each carried a gabion, which of course was not enough to carry out the requisite repairs. Our officer, charged with the superintendence of the working party, observed this, and said so to the sapper officer, as the gabions were not sufficient to revet one embrasure, let alone the parapet. The sapper officer answered that his orders were only to repair the damages in the battery and not to carry out new works; that if we wished to do so, we should have to use our own men and do it ourselves, as the duty of the sappers was to superintend the works and not to execute them, and all changes in the works had to be carried out by the troops occupying them. He had right on his side, and the question was where were we to get gabions and fascines. We could not make them in the battery, and if we could have done so, where was the brushwood to come from? To this he proposed that a fatigue party of our men should be sent down to the sappers bivouac. But this we could not do under any circumstances; we should have to take men away from the guns, and if we had to fire again in the night time what should we have done? The sapper officer observed, with justice, that we could fire with diminished numbers. We replied that it was possible, but that we could not answer for the steadiness of the detachments. We knew well from our short experience of active service that with diminished numbers the loading is not so well performed, and that running-up is much hindered. Our usual practice was to keep the Nos. 5 and 6 in the lodgments, No. 5 got the tube ready, while No. 6 took

SAEL
HI
LOSE
Scale Inches.
SHIPI
Scale


Devyatiglazaya Battery.
MAGI BEDEK.
Mortar Bty.
SAEBARNAYA HILL.
Skorostrelnaya Bty. N°1.
Metscherski Bty. N°3.
Fougasses.
MT. ST. NICHOLAS.
Steel Bty.
N°1 Mortar Bty.
LOSEK HILL.
Gornaya Bty.
WOODY SPUR.
WOODY HILL.
Storm Bty. N°2.
Storm Bty. N°1.
VOLHYNIAN HILL.
Skorostrelnaya Bty. N°2.
Round Bty.
Central Bty.
N°2 Mortar Bty.
Dragomiroff Bty.
Gornaya Battery.
Sappers Camp.
N.
Scale Inches.
Polyagina Bty.
SHIPKA PASS. 1877.
Scale, 700 Mètres to 1 In.
Reserve Camp.
CUSTOM HOUSE.
Russian Trenches.
" Batteries.
Turkish Works.
TO GABROVA
H.D.Q.

the cartridge out of its case, and his assistant gave it to No. 3, so that each number had his work cut out for him. (This proceeding had been adopted on the advice of the officers of the 2nd battery, and worked very well). In the first place, then, it was difficult to work the guns with diminished numbers; and secondly, if we had had to do it, the cartridges would have to have been left exposed in the magazines, which was very dangerous.

The dispute was settled by the fortunate arrival of a squad of sappers with revetting materials, which had not been required in another battery. Our commander at once reported to the officer commanding the position, that the quantity of materials supplied was totally insufficient, and the latter thereupon ordered a fatigue party of infantry to bring up gabions and fascines from the sappers' bivouac. The sapper officer pointed out to the sappers the work to be done, and then went off to another battery. Our own officer on duty pointed out the most pressing repairs, and placed the sappers to superintend the detachments, each of which worked in their own gun portion. The men worked very zealously, for they knew that the more they toiled the safer would living in the battery become. In that night we increased the height of the parapet, revetted the embrasures with gabions and fascines, and placed large flagstones under the trails and wheels and on the line of recoil. We had only material enough to revet two-thirds of the front face of the rear traverse with fascines, beginning from the bottom, but this was almost enough, as the fascines took the blow of the trail very well, and prevented it from penetrating. At 2 a.m. the works were finished, and the men, who had been working for four consecutive hours, lay down to rest in comparative safety.

THE ARTILLERY AND ENGINEER JOURNAL.

From the Italian,

BY

CAPT. A. E. TURNER, R.H.A.

Among the changes of *matériel*, &c., notified in the first number of the *Giornale d'Artiglieria e Genio* for the current year, the following are worthy of notice, viz. :—

1. The introduction of linen cartridges for the 24^{cm} and 32^{cm} guns (8·7 ins. and 12·6 ins.); the length of the cartridge for the larger gun is 27½ ins.

2. The introduction of serge bags to contain the bursting charges of common shells for the same guns.

3. The adoption of a new pattern common shell for the larger gun above-mentioned; it is of cast-iron with a hardened head; in the interior of the shell is a trunco-conoidal chamber to hold the bursting charge, communicating with the base by means of a cylindrical passage cut through its thickness, and tapped with a screw, to receive a screw plug of the same metal as that of the shell, but with a brass washer beneath its head, to rest on the base of the shell; two rings project from the base for the convenience of carrying the shell by means of a movable handle, the ends of which are hooked to fit into the rings.

Total length of shell...		36·68 ins. (including rings).
Weight of	bursting charge ...	9 lbs.
	shell, filled... ...	763·4 lbs.

Three copper rings, equi-distant from one another, but of different thicknesses, project from the cylindrical part of the shell. The projections of the front ring being ·051-in., that of the centre ·18-in., and that of the rear ·279-in.

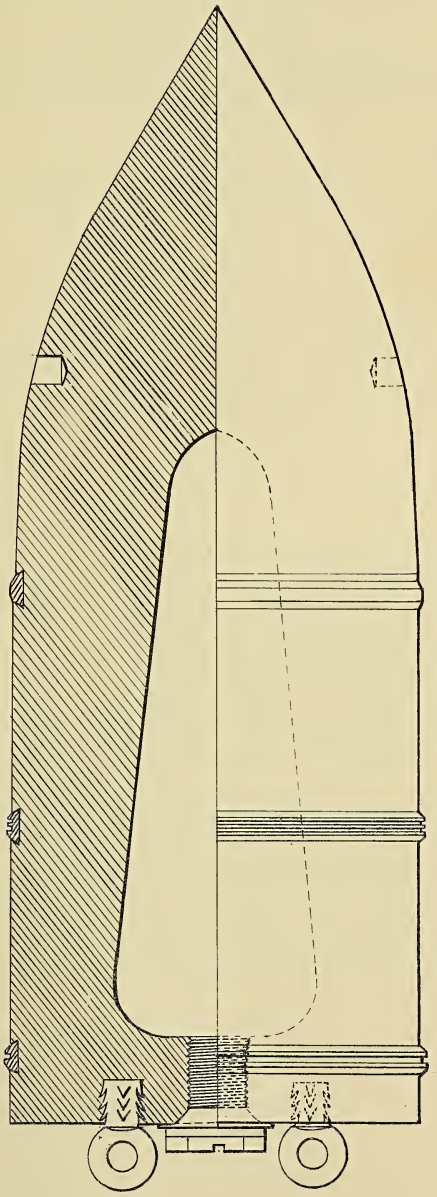
Minute instructions are given as to the employment of wooden and zinc plugs for shells, when not fuzed.

Muzzle-loading common shells and shrapnels are always to be fitted with the former for transport, and when fired as plugged shells.

Breech-loading common shells and shrapnels of 12^{cm} and upwards (4·7 ins.), are to be fitted with wooden plugs for transport, but with zinc plugs when filled with sand, and fired as plugged shells: while for common shells and shrapnels of breech-loading field guns, zinc plugs are to be used for both purposes.

Common shells of the 7^{cm} (2·7 ins.) mountain gun are to be fitted with zinc plugs, while shrapnels of the same calibre are to be fitted with wooden.

COMMON SHELL WITH HARDENED HEAD FOR C M.32 (12"·6) GUN.



ON FIXING POSITIONS

BY THE

MORE SIMPLE ASTRONOMICAL OBSERVATIONS,

FOR THE USE OF

R.A. OFFICERS ENGAGED IN EXPLORATION,

BY

MAJOR E. S. GORDON, R.A.

The following brief summary of some of the handiest methods of determining Latitude, Longitude, and Compass Variation, is submitted for the use of R.A. officers on foreign stations who may be starting from thence on journies of exploration, in which they wish to obtain accurate and useful Geographical results—in the hope that the hints offered may be found useful to them in such expeditions, when frequently, from defective maps or other causes, independent observations are found absolutely necessary.

Treatises on this wide subject, which generally also deal much in theory, are mostly bulky and expensive; it is therefore hoped that to bring together a few of the most important practical operations may not be out of place in these "Proceedings." They are not intended to take the place of, but rather to induce to, a more extended study of the question. Beyond a general acquaintance with the methods of computation, nothing further is required than the ordinary knowledge of logarithms, and fair proficiency in the use of the sextant and mercurial horizon.

The author is indebted to his friend Mr. Coles, Instructor in Surveying and Mapping to the Royal Geographical Society, who has kindly looked through the paper, and supplied a valuable table (A) of Reductions for Hour Angles in Time, together with the hitherto unpublished forms for working out examples here given, containing directions for application of the rules to different circumstances. Blank copies of these forms prepared beforehand will be found of great use in computing observations.

It is proposed to discuss the following operations:—

I.—Finding the Latitude.

(*a*) *By Meridian Altitude of the Sun.*
(*b*) *By Reduction to the Meridian.*
(*c*) *By Altitude of Pole Star out of Meridian.*

Subjects.

II.—Finding the Longitude.

(*a*) *By finding Apparent Time at place by Altitude of the Sun, and thence the Longitude by chronometer.*

(*b*) *Ditto by Altitude of a Star or Planet, and thence Longitude by chronometer.*

III.—Finding Variation of Compass by Amplitude.

Advantages of star observations.

In estimating generally, for Latitude and Longitude, the relative advantages of Sun and Star Observations, the latter are practically found to be—

(1) Greater exactitude obtained by the smallness of the objects reflected.

(2) The observations can be taken at leisure without exposure to the glare of the mid-day sun.

(3) The brilliancy of stars in tropical climates renders their use favorable in those latitudes.

(4) Near the Equator, where the Declination and Latitude are nearly the same, it is impossible to take the double arc by sextant, while a suitable star can always be selected.

The more complicated but not less serviceable methods by Lunar Observations must be omitted in this paper for want of space.

Instruments.

Instruments

It may here be well to very briefly note the most important instruments necessary in these expeditions.

Sextant.

A sextant of 6 inch or 4 inch radius. The former, reading to 10 seconds, is scarcely necessary, unless the traveller intends to take lunar observations. The 4 inch, graduated to 20 seconds, is more portable, and gives all requisite accuracy.

Adjustments

The principal adjustment is to see that the reflectors are vertical to, and that the line of collimation is parallel to, the plane of the instrument. The mode of adjusting the horizon glass varies in different instruments. The index glass should *never* be touched, as this should always be put into proper adjustment by the maker, and is not liable to shift. The line of collimation is adjusted by the small screws in the collar, into which the telescope is screwed.

Index error.

The index error, which has to be applied to all observed altitudes, can be found by measuring the sun's horizontal diameter, noting the reading *on* the arc. Then reverse the images by moving the index the opposite way, and take the measure again, this time reading *off* the

By sun.

arc; half the difference of the two readings will be the index error, *minus* if the reading *on* the arc be the greater, *plus* if the reading *off* the arc be the greater. To test the accuracy of the observation, one fourth of the sum of the two readings should be equal to the sun's semi-diameter, as given in the nautical almanack for date in current year.

By star.

Another method, by means of a star, is this. Set the vernier to zero, and, looking through the inverting telescope at the star, make,

with the tangent screw, the reflected star coincide with the one seen by direct vision. The reading on the arc will be the index error, *minus* if *on* the arc, *plus* if *off* the arc.

Artificial horizon.

A very handy instrument, by Staff Commander George, R.N., is in general use by the Royal Geographical Society, and furnished by it to travellers. It consists of two small cisterns, of which one has a glass cover screwing on and off, the other holds the mercury used for the reflection. They are connected by a neck in which is a tap for letting the mercury out of the latter cistern into the former. When this is done the tap is closed, the glass unscrewed, and a carefully ground disc of glass is dropped on to the quicksilver on which it floats, making a good steady surface on which to take an observation. The diameter is 3·14 ins. A great advantage is that you have never to touch the mercury, and without great carelessness it is impossible to lose it. In still weather the glass may be dispensed with.

Compass.

The card should be half black, half white, to make it readable in a dim twilight. The graduations should range from 0° to 360° right round, not twice over from 0° to 180°. The needle should work steadily and quickly, not make long, slow oscillations. It may be adjusted to obviate depression from dip, by a sliding collar. A line for True North temporarily marked on the card in a position most appropriate to the magnetic variation of the country to be visited, is convenient.

Watch.

As the accuracy of an observation depends on the precision of the recorded time, the watch used should be a half-chronometer—that is to say, a lever watch with compensated balance, and carefully tempered pendulum spring: on these two considerations its ability to keep a steady rate chiefly depends. Great care should be taken to see that there is perfect coincidence in the pointing of the seconds hand to zero when the minute hand points to a division, otherwise the observer cannot tell to which minute the seconds belong. The case should have neither hinge nor spring.

Aneroid.

This should be capable of working without fracture over the highest mountain pass that is expected. It must be borne in mind that the aneroid, though excellent for differential observations, is unreliable for *absolute* heights, unless checked by boiling point barometer, as its index error is apt to vary without the traveller being able to ascertain or allow for the change. It is also uncertain at high altitudes, and cannot be depended on for giving correct measurements when *descending* from elevations. It has been simply alluded to as a useful instrument, and space does not admit of any remarks of its use for obtaining the differences in height between two stations.

Thermometers.

Maximum and minimum thermometers—these should be graduated on the stems, and it would be advisable to have them originally tested at Kew, and their errors there determinated and tabulated. Such a certificate will be sufficient for all practical purposes, as good thermometers are very slow to change their errors.

Tables.

Raper's navigation Tables, 12th edition, contain almost every Reduction. The chief recommendation of this book is the handiness of the tables, affording at a single reference results which would otherwise

give much trouble to work out. It is officially adopted for H.M. ships, and is the text book of the Hydrographic Office.

Nautical Almanack.

The Nautical Almanack. This can be bought for 2s., and is issued three years in advance.

Abbreviations.

The following usual abbreviations are adopted:—⊙, Sun; ☉, Sun's Upper Limb; ☉, Sun's Lower Limb; A.T., Apparent Time; G.D., Greenwich Date; G.M.T., Greenwich Mean Time; Z.D., Zenith Distance; M.Z.D., Meridian Zenith Distance; R.A., Right Ascension; N.A., Nautical Almanack; D.R., Dead Reckoning—*i.e.*, reckoning by account.

Latitude.

I.—*Finding the Latitude.*

Meridian altitude.

(*a*) *By Meridian Altitude of the* ⊙.

This is a simple application of the rule that latitude is the sum of the Declination and Z.D. when both are N. or both S., and is their difference when they are of different names, or one N. and one S.

Example.—March 11th, 1881, observed the meridian altitude of ☉ in an artificial horizon 70° 34′ 10″, index error of sextant −3′ 10″, longitude 0° 7′ 45″ W., ⊙ bearing south. Required the Latitude:—

	°	′	″			°	′	″
Declination, p. 1., N.A....	3	32	6·2 S	Observed alt. in quicksilver ...		70	34	10
Correction, tab. 19 Raper	0	0	0	Index error.....	−		3	10
Reduced declination	3	32	6·2 S		2)	70	31	0
						35	15	30
				Refraction, tab. 31 Raper.....	−		1	22
						35	14	8
				Semi diamr. ☉, tab. 34 Raper...	−		16	8
						34	58	0
				Parallax, tab. 34 Raper	+			7
						34	58	7
						90	00	0
				Z.D.		55	1	53 N.
				Declination ...		3	32	6 S.
				Latitude		51	29	47 N.

Finding the Latitude.

(*b*) *By Reduction to the Meridian.*

Reduction to the meridian.

This observation may be taken either before noon or after noon, or some of the altitudes may be taken on each side of the meridian; in any case, the observations should not be taken at a greater interval than 25 minutes from noon, but the nearer to noon the better. It is usually called circum-meridional, because a set of the observations may be taken on either side of the meridian. It may be of especial value to officers abroad, as the altitudes can be taken without a chronometer or superior watch.

A most valuable table (A) of reductions for Hour Angles in Time is here given; it saves much labour in working out these observations, and is only to be found in very few books.

[A]

Formula .. Reduction $= \frac{\text{Cos. Declination} \times \text{Cos. Lat.}}{\text{Sin. Z Dist.}} \times \frac{2 \text{ Sin.}^2 \frac{1}{2} \text{ hour } \Delta}{\text{Sin. } 1''}$.

Values of .. $\frac{2 \text{ Sin.}^2 \frac{1}{2} \text{ hour } \Delta}{\text{Sin. } 1''}$.

Seconds.	Hour Angles in Time.																		
	0m	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m
0	0	2	8	18	31	49	71	96	126	159	196	237	283	332	385	442	502	567	636	708
1	0	2	8	18	32	49	71	97	126	160	197	238	283	333	386	443	503	568	637	710
2	0	2	8	18	32	50	71	97	127	160	198	239	284	333	387	444	505	569	638	711
3	0	2	8	18	32	50	72	98	127	161	198	240	285	334	387	445	506	570	639	712
4	0	2	8	18	32	50	72	98	128	161	199	240	286	335	388	446	507	572	641	713
5	0	2	8	19	33	51	73	98	128	162	200	241	287	336	389	446	508	573	642	715
6	0	2	9	19	33	51	73	99	129	163	200	242	287	337	390	447	509	574	643	716
7	0	2	9	19	33	51	73	99	129	163	201	243	288	338	391	448	510	575	644	717
8	0	2	9	19	33	52	74	100	130	164	202	243	289	339	392	449	511	576	645	718
9	0	3	9	19	34	52	74	100	130	164	202	244	290	339	393	450	512	577	646	720
10	0	3	9	20	34	52	75	101	131	165	203	245	291	340	394	451	513	578	648	721
11	0	3	9	20	34	53	75	101	131	166	204	245	291	341	395	452	514	579	649	722
12	0	3	9	20	35	53	75	102	132	166	204	246	292	342	396	453	515	581	650	723
13	0	3	10	20	35	53	76	102	133	167	205	247	293	343	397	454	516	582	651	725
14	0	3	10	20	35	54	76	103	133	167	206	248	294	344	398	455	517	583	652	726
15	0	3	10	21	35	54	77	103	134	168	206	248	295	345	399	456	518	584	654	727
16	0	3	10	21	36	54	77	104	134	169	207	249	295	345	399	457	519	585	655	728
17	0	3	10	21	36	55	77	104	135	169	208	250	296	346	400	458	520	586	656	730
18	0	3	10	21	36	55	78	105	135	170	208	251	297	347	401	459	521	587	657	731
19	0	3	10	22	37	55	78	105	136	170	209	251	298	348	402	461	522	588	658	732
20	0	3	11	22	37	56	79	106	136	171	210	252	299	349	403	461	524	590	660	733
21	0	4	11	22	37	56	79	106	137	172	210	253	299	350	404	463	525	591	661	735
22	0	4	11	22	37	56	80	107	137	172	211	254	300	351	405	463	526	592	662	736
23	0	4	11	22	38	57	80	107	138	173	212	254	301	352	406	464	527	593	663	737
24	0	4	11	23	38	57	80	107	138	173	212	255	302	352	407	465	528	594	664	738
25	0	4	11	23	38	58	81	108	139	174	213	256	303	353	408	466	529	595	666	740
26	0	4	12	23	39	58	81	108	140	175	214	257	303	354	409	467	530	596	667	741
27	0	4	12	23	39	58	82	109	140	175	214	257	304	355	410	468	531	598	668	742
28	0	4	12	24	39	59	82	109	141	176	215	258	305	356	411	470	532	599	669	744
29	0	4	12	24	39	59	82	110	141	177	216	259	306	357	412	470	533	600	670	745
30	1	4	12	24	40	59	83	110	142	177	216	260	307	358	413	471	534	601	672	746
31	1	4	12	24	40	60	83	111	142	178	217	260	307	359	414	473	535	602	673	747
32	1	5	13	24	40	60	84	111	143	178	218	261	308	359	415	474	536	603	674	749
33	1	5	13	25	41	60	84	112	143	179	218	262	309	360	415	475	538	604	675	750
34	1	5	13	25	41	61	85	112	144	180	219	263	310	361	416	476	539	606	676	751
35	1	5	13	25	41	61	85	113	145	180	220	263	311	362	417	477	540	607	678	753
36	1	5	13	25	41	62	85	113	145	181	221	264	312	363	418	478	541	608	679	754
37	1	5	13	26	42	62	86	114	146	182	221	265	312	364	419	479	542	609	680	755
38	1	5	14	26	42	62	86	114	146	182	222	266	313	365	420	480	543	610	681	756
39	1	5	14	26	42	63	87	115	147	183	223	266	314	366	421	481	544	611	683	758
40	1	5	14	26	43	63	87	115	147	183	223	267	315	367	422	482	545	612	684	759
41	1	6	14	27	43	63	88	116	148	184	224	268	316	367	423	483	546	614	685	760
42	1	6	14	27	43	64	88	116	149	185	225	269	317	368	424	484	547	615	686	761
43	1	6	14	27	44	64	89	117	149	185	225	269	317	369	425	485	548	616	687	763
44	1	6	15	27	44	64	89	117	150	186	226	270	318	370	426	486	549	617	689	764
45	1	6	15	28	44	65	89	118	150	187	227	271	319	371	427	487	551	618	690	765
46	1	6	15	28	45	65	90	118	151	187	228	272	320	372	428	488	552	619	691	767
47	1	6	15	28	45	66	90	119	151	188	228	273	321	373	429	489	553	621	692	768
48	1	6	15	28	45	66	91	119	152	188	229	273	322	374	430	490	554	622	694	769
49	1	6	16	29	45	66	91	120	153	189	230	274	322	375	431	491	555	623	695	771
50	1	7	16	29	46	67	92	120	153	190	230	275	323	376	432	492	556	624	696	772
51	1	7	16	29	46	67	92	121	154	190	231	276	324	376	433	493	557	625	697	773
52	2	7	16	29	46	68	93	121	154	191	232	276	325	377	434	494	558	626	698	774
53	2	7	16	30	47	68	93	122	155	192	232	277	326	378	435	495	559	628	700	776
54	2	7	16	30	47	68	93	122	155	192	233	278	327	379	436	496	560	629	701	777
55	2	7	17	30	47	69	94	123	156	193	234	279	327	380	437	497	562	630	702	778
56	2	7	17	30	48	69	94	124	157	194	235	279	328	381	438	498	563	631	703	780
57	2	7	17	31	48	69	95	124	157	194	235	280	329	382	439	499	564	632	705	781
58	2	8	17	31	48	70	95	125	158	195	236	281	330	383	440	500	565	633	706	782
59	2	8	17	31	49	70	96	125	158	196	237	282	331	384	441	501	566	635	707	784

Example.—March 10th, 1881, in a place whose estimated latitude was 51° 28′ N., longitude 0° 7′ 45″ W., took the following observations and times to determine the latitude. Error of watch on G.M.T., Feb. 25th, was 10 secs. slow, and its rate was 1 sec. losing. Its error on A.T. was 10′ 25″ fast. Index error of sextant −3′ 10″. Find the latitude.

Latitude 51° 28′ N. by account, ⊙ bearing south.

Times by watch.	Alt. art. horizon.
h. m. sec.	° ′ ″
11 57 9	68 33 40
11 58 19	68 35 00
11 59 25	68 35 40
3) 35 54 53	3) 205 44 20
Mean 11 58 17	Mean 68 34 46

	m.	s.
Equation of time (p. i. N.A.) ...	10	22
Corr. by hourly diff. N.A.	0	0
Corr. Eq. T. to apparent time	10	22

	Month. Day.	h.	m.	sec.
Noon ⊙ on meridian		00	00	00
Long. 0 7 45 in time, (tab. 17 Raper)	1881, Mar. 10 +			31
G.D. of transit (apparent time)	Mar. 10 ...			31
		h.	m.	sec.
Mean of the times by watch		11	58	17
Error of watch for G.M.T.	+			3
G.D. corresponding to the mean of the observations,	Mar. 9 ...	23	58	20

	Month. Day.	°	′	″
Decln. at mean noon (p. ii. N.A.)	Mar. 10...	3	55	49
Corr. by hourly diff. N.A.	+			1
Decln. at mean of the times		3	55	50

To find what time the Watch will show at Noon.

	h.	m.	sec.
Time of noon	12	00	00
† Error of watch on apparent time...	0	10	25
Time the *watch* will show at noon =	12	10	25

† The error of watch on A.T. should be found by a sight, in the usual way, and can be found from the Hour ∠ of the sights used for finding Longitudes by chronometer.

Take the difference between the time the watch will show at noon and each of the times shown by the watch when the altitudes were, and the differences will be the Hour Angles.

Watch shows h. m. sec. at noon.

Watch times.	Hour angles.	Nos. table A above.	⊙'s mer. zenith dist. nearly.
h. m. s.	° ′ ″		° ′ ″
11 57 9	0 13 16	345	Decl. noon 3 55 50
11 58 19	0 12 6	287	Lat.(D.R.) 51 28 0
11 59 25	0 11 0	237	Mer. Z.D. 55 23 50

N.B.—The meridian zenith distance is equal to the sum of the latitude and declination when they are contrary names; or their difference when of the same names.

3) 869

Mean ... 289·6 = N. (above)

	°	′	″	
Lat. D.R.	51	28	0	Cos. 9·794467
Decl.	3	55	50	Cos. 9·998977
M.Z.D. ...	55	23	50	Cosec. 0·084572
N. ... 289·6				Log. 2·461799
In ″ 218·7				Log. 2·339815
Reduction ...	3	18·7		

		°	′	″
Observed altitude ☉		68	34	46
Index error	−	0	3	10
If taken in Quicksilver, divide by 2		68	31	36
		34	15	48
Refraction	−		1	25
		13	14	23
Semidiameter.....	+		16	8
		34	20	31
Parallax	+			6·5
		34	30	37·5
Reduction.....			3	38·7
Meridian altitudes ...		34	34	16·2
		90	00	00
Meridian zenith dist.		55	25	23·8N.
Declination		3	55	50 S.
Latitude		51	29	33·8N.

Finding the Latitude.

(*c*) *By Pole Star out of the meridian.* Pole star.

This is a very convenient method of finding the Latitude, as the observation may be taken at any time when the star is visible; it is, however, a somewhat difficult star to take in the artificial horizon.

The tables necessary for this form of computation can only be found in Nautical Almanack for each year.

Example.—Feb. 18, 1877, at 9 h. 20 m. M.T. at place, in long. 30° 10′ 0″ W.; the observed alt. of Polaris was 92° 1′ 0″; index error, −10.″ Find the Latitude.

	h.	m.	s.
M.T., Feb. 18	9	20	0
Diff. long. 30° 10′ 0″ in time (tab. 17, Raper)	2	0	40
days			
G.M.T. 18	11	20	40
	h.	m.	secs.
Siderial Time at Greenwich Mean Noon (p. ii. NA.)	21	54	12·45
Acceleration for 11 h.		1	48·42
" 20 m.			3·29
" 40 secs.			0·11
	21	56	4·27
M.T. at place	9	20	0
	31	16	4·27
	24	00	0
Siderial time of observation	7	16	4·27
	°	′	″
Observed altitude	92	1	0
Index error −		10	0
2)	91	51	0
	45	55	30
Refraction −			56
	45	54	34
Subtract −		1	0
Reduced altitude	45	53	34
h. m. sec.			
With argument 7 16 4·27 (1st correction) +		1	5
Approximate Latitude	45	54	39
h. m.			
With arguments 45° 54′ and 7 16 (2nd corrn.) +			57
	45	55	36
h. m.			
With arguments Feb. 18, 1877, and 7 16 (3rd corr.) +		1	2
Latitude of the place	45	56	38

II.—Finding the Longitude. Longitude.

(*a*) *By finding Apparent Time at place by altitude of the sun, and thence the Longitude by chronometer.* Sun-chronometer.

This is a most useful observation, but it must be borne in mind that it is only available when the observer is acquainted with the error of

his watch on G.M.T., and with its daily rate. This is shown in the example :—1881, March 10th, A.M. at place, the following observations were taken to find Apparent Time at place, and thence the Longitude; the error of the watch, Feb. 25th, was 10 seconds fast, and its rate was 1 second losing daily.

LONGITUDE BY ALTITUDE OF THE SUN.

LATITUDE, 51° 31′ 00″.

Month. Day.	Times by watch. h.	m.	sec.
March 10th	10	19	33
	10	20	12
	10	20	51
3)	31	00	36
Mean	10	20	12
Error ..... —			10
	10	20	2
Acctd. rate ..... +			13
G.D. March 9th...	22	20	15

† When great exactness is required, note thermometer and barometer, and correct refraction by tables 32 and 33 of Raper, or by any similar table.

☉'s alt. in quicksilver.	°	′	″
	58	55	00
	59	00	30
	59	8	00
3)	177	3	30
Mean	59	1	10
Index error..... —		3	10
2)	58	58	00
Reduced alt.	29	29	00
†Refraction ... —		1	43
	29	27	17
Semi diameter... +		16	8
	29	43	25
Parallax ..... +			7
True altitude	29	43	32

Original error of watch 10 secs. fast.			
Daily rate	1 sec. losing.		
Interval	13 days.		
Accumulated rate	13		
	°	′	″
Declination, (p. ii. N.A.)	4	19	19 S.
Hourly diff. ...		21	48
Red. decl.	3	57	31
	h.	m.	secs.
Eq. time (p. ii. N.A. ...)	9	10	37·45
Hourly diff. —			15
Red. eq. time...		10	22
	°	′	″
Declination.....	3	57	31 S
	90	00	00
Polar dist.	93	57	31

	°	′	″
Altitude	29	43	32
Latitude.....	51	31	00
Polar dist.	93	57	31
Sum..... 2)	175	12	3
½ sum	87	36	1
Diff. between alt. and ½ sum	57	52	29

Sec.	0·206009
Cosec.	0·001037
Cosin.	8·621962
Sin.	9·927827
Log. sin. square...	8·756835

If the sights are A.M. subtract the hour ∠ from 24 hours, and the remainder is app. time at place, reckoned from the preceding day.

	h.	m.	sec.	
Hour ∠	1	50	38	
	24	0	0	
	22	9	22	
+		10	22	= Eq. time.
	22	19	44	Mean time at place.
	22	20	15	G.M.T.
			31	Longitude in time 0° 7′ 45″ W.

The best time to take sights is when the sun is about four hours from the meridian.

FINDING THE LONGITUDE.

Star-chronometer.

(*b*) *Finding A.T. at place by Altitude of a Star or Planet, and thence the Longitude by chronometer.*

The following example is that of a *planet*, Venus, in which the Declination and R.A. have to be corrected for G.M.T., and parallax has to be applied to obtain the True Altitude.

When a *star* is observed no correction is required for R.A. or declination, and stars have no parallax.

Example.—March 11th, 1881, P.M., at place, the following observations of Venus (W. of meridian) were taken to find A.T. at place, and thence the longitude. Index error − 3 m. 10 secs., the error of watch on Feb. 22nd, 1881, was 30 secs. fast on G.M.T., and its daily rate was 1 sec. gaining. Lat. 51° 30′ 30″

LONGITUDE BY ALTITUDE OF A STAR OR PLANET.

LATITUDE, 51° 30′ 30″ N.

Date, 1881. Month. Day.	Times by watch. h.	m.	sec.
March 11th	7	30	13
	7	31	19
	7	32	28
3)	22	34	00
Mean	7	31	20
Error of watch... −			30
	7	30	50
Accumulated rate −			17
Month. Day.			
G.M.T., March 11th	7	30	33

Alts. of star in artl. horizon.	°	′	″
	52	16	10
	52	32	20
	52	48	30
3)	157	37	00
Mean	52	32	20
Index error ... −		3	10
2)	52	29	10
	26	14	35
Refraction..... −		1	57
	26	12	38
Parallax in altitude (tab. 45 Raper) +			13
True alt.	26	12	51

	h.	m.	sec.
*'s R.A. (N.A.) ...	2	10	47
	°	′	″
*'s Decln. (N.A.)	17	17	45 N.
	90		
*'s Polar dist.....	72	42	15 N.
	h.	m.	sec.
Siderial time (p. ii. N.A.) Mar. 11	23	17	8·81
Acceln. for 7h. =	0	1	9
" 30m. =	0	4	4·93
" 33 secs. =	0	0	0·09
Mean sun's R.A. =	23	18	22·83

	°	′	″		
*'s true alt.....	26	12	51		
Latitude.....	51	30	30	Sec.....	0·205930
Polar dist.	72	42	15	Cosec.....	0·020095
Sum ..... 2)	150	25	36		
½ sum	75	12	48	Cosin.....	9·406918
½ sum − alt. = remdr. =	48	59	57	Sin.....	9·877777

	h.	m.	secs.		
*'s hour ∠	4	37	37	= Log. sin. sqre. =	9·510710
*'s R.A.	2	10	47		
R.A. of meridian	6	48	24		
Mean sun's R.A.	23	18	23		
M.T. at place	7	30	1		
G.M.T.	7	30	33		
Long. in time.....			32	= 0° 8′ 0″ longitude, W.	

N.B.—When the star is to the west of the meridian add the hour ∠ to the star's R.A.; when to the east, subtract the star's Hour ∠ from its R.A. (increased if necessary by 24 hours); the result is the R.A. of the Meridian. From the R.A. of the Meridian (increased if necessary by 24 hours) substract the R.A. of the Mean Sun, and the result will be the Mean Time at place of observation.

III.—FINDING VARIATION OF COMPASS BY AMPLITUDE.

Variation of compass.

Example.—On 6th Jan., 1872, at 4 h. 44 m. 27s., A.M., A.T. at place, in Latitude 37° 59′ S., and Longitude 36° 24′ W., the sun's Magnetic

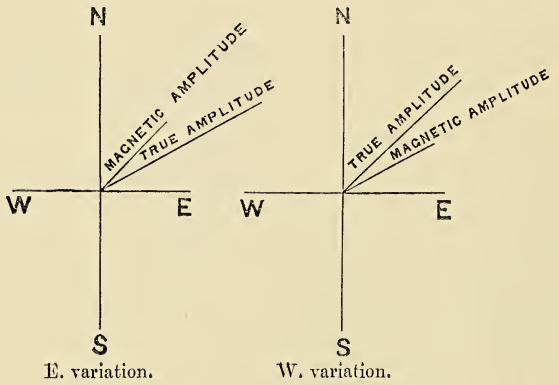
Amplitude was S.E.bE.$\frac{1}{2}$E. Required the True Amplitude, and the error of the compass.

	Month. Day.	h.	m.	secs.	
Date at place, A.T., January 5th		16	44	27	
Correct for long. in time 36° 34′ (tab. 17, Raper)	+	2	25	36	
G.D., 5th		19	10	2	
		°	′	″	
Sun's declin. (p. i., N.A.)		22	39	49	S, and decreasing.
Hourly difference	−		5	16	
Corrected declination		22	34	33	S.

	°	′	″		
Declination	22	34	33	S.	Sin. 9·584210 (Tab. 68, Raper.)
Latitude	37	59	0	S.	Sec. 10·103369
True amplitude, E.	29	8	30		9·687579 (Tab. 68, Raper.)
Compass bearing, E.	28	7	30		
Error of compass	1	1	0	E.	

As this subject of Variation is somewhat confusing, it will be found convenient to adopt the following plan :—

Draw a cross, marking the four cardinal points with their initials; on this, project the true and magnetic amplitudes; then, turning the point where they meet in the centre towards you, if the true amplitude is seen to the *right* of the magnetic amplitude the variation is E., but if the true amplitude is to the left the variation is W., as in figures :—



E. variation. W. variation.

In the example above the true amplitude is to the *right* of the magnetic amplitude, and the compass variation is E.

The foregoing examples are those of observations which have been taken in an artificial horizon; in such cases, as has been shown, it is always necessary—1st, to apply the index error of the instrument to the observed angle, and then to divide the angle by 2.

Limits of accuracy.

In conclusion, any one who has had some previous experience in the use of the sextant and artificial horizon, ought, by means of such observations, to fix his position within one mile of Latitude, and two miles of Longitude, always supposing that he is acquainted with the index error of his sextant, and the error and rate of his watch.

THE EQUIPMENT OF FIELD ARTILLERY.

BY

CAPT. J. R. J. JOCELYN, R.A.

(The R. A. Institution Gold Medal Prize Essay, 1881.)

"The first essential of an efficient field artillery is to shoot well—everything else is but a means to an end."—*Colonel Fox Strangways, R.A.*

Three equipments necessary for field purposes.

1. We should possess three kinds of equipments for field purposes, namely:—one so light that the speed of the horse can be utilized up to the highest rate that mounted troops can employ; a second of the greatest weight (and therefore possessing the greatest shell-power) that can be brought into the field; and a third that shall combine a moderate mobility with the greatest shell-power the weight will admit of: that is to say, we should have a *horse artillery equipment* drawn by six horses, as that is the greatest number that can be usefully employed together in a team where great speed is a desideratum; a *field artillery equipment* drawn by eight horses, for a team of eight horses can be employed where the trot is the normal pace; and an *equipment for guns of position* drawn by twelve horses four abreast, such a combination being admissible where transport at a slow pace is all that is necessary. Two of these equipments are provided for in all European army corps, but of late years the gun of position has been neglected, though thereby the artillery has given up a sure source of power and effect; it is strange, however, that the good work done by 18-prs. in the Crimea should be, by us at least, so soon forgotten. Taking for granted that these three equipments are necessary, we will proceed to discuss them in detail, first determining the greatest weight of metal that can be assigned to each. This being fixed, we can take each item separately and consider what alterations can be suggested therein; and in this we shall be greatly assisted by a study of the improvements lately introduced into foreign artilleries, most of which have been remodelled in the light of modern experience: we can then judge how the total weights arrived at satisfy the requirements of mobility.

The question of the weight of metal permissible in the guns of the three equipments.

2. The weights of these guns depend upon the amount a horse can draw at different speeds. Now traction is a subject upon which authorities differ, and, indeed, it is almost impossible to theorise upon a matter into which such a variable and delicate factor as a horse's strength enters; but as calculations on this subject are usually based

on the assumption that high speeds are maintained for long periods, and that such periods are of daily occurrence, the results so obtained will not err by being too large, as a quick pace is only occasionally demanded. The following theoretical results may be stated.* A team of six horses can, for *horse artillery* purposes, draw a weight of 3708 lbs.; a team of eight horses for *field artillery* purposes an equipment of 5429 lbs.; and a team of 12 horses can transport, at a walk, a weight of 103 cwt., the resistance to rolling being the same as that taken into consideration in the two former weights.

Comparison of actual weights with theoretical results.

3. In the new equipments introduced on the continent during the last few years, teams of over six horses are not employed: we cannot therefore seek comparisons abroad for *field* and *heavy batteries* with the larger teams, but it will be instructive to consider the weights of various horse artillery equipments, it being understood in each case that two *light gunners* are supposed to be carried on the limbers:—

		Weight of equipment.
Austrian 10½-pr.		3695 lb.
French 12-pr.		3789 "
Russian 15-pr.		3972 "
German 11-pr.		4240 "
English 13-pr.	M. L.	4408 "
	B. L.	4746 "

It will thus be seen that the Austrian and French equipment agree very closely with the calculated weight, and the experimental 13-pr. of this country is by far the heaviest, and there can be little doubt it is rather ponderous for horse artillery purposes.

The equipment of the Horse Artillery 9-prs. of 6 cwt. weighs 4128 lbs., and, while not erring very much against theory, has in practice been found quite light enough to enable the full speed of the horse to be utilized; it will therefore be wiser in our future equipment not to go beyond this weight (37 cwt.) With regard to the eight-horsed field battery, our own practice agrees very closely with theory; the equipment of the 16-pr. with five light gunners carried being little more than the calculated load for eight horses, the former being 5484 lbs., the latter 5429 lbs.

The limit of weight for horse and field batteries.

4 These two weights, 37 cwt. and 50 cwt., may therefore be taken as the correct ones for horse and field batteries, and we must seek the heaviest metal consistent therewith, remembering always that a sufficiency of ammunition must be carried; it will be convenient to follow up this part of the question here, reserving the case of the position gun for discussion afterwards.

The weight of ammunition carried will determine the weight of metal allowable in the gun.

5. The greatest expenditure of ammunition in any one day during the Franco-German war was† at Mars la Tour, where the artillery of the III. German Army Corps fired on an average 130 rounds per gun, the light batteries, as might be expected, firing more than the heavy;

* Vide "Traction," by Major Kemmis, R.A., R.A.I. Papers, Vol. IX., pp. 477-8-9.

† Vide Hoffbaur, "The German Artillery," Appendix, pp. 370 et seq.

thus, for example, one horse artillery battery fired 1164 rounds, or 194 rounds per gun; but in this particular action the work that fell upon the guns of the III. Corps was altogether abnormal; it therefore appears that we can rest satisfied with the number of rounds we at present carry, which gives an average of 124 rounds per gun throughout the Army Corps, but this amount should not be in the least diminished. Let us assume, therefore, that we shall still carry 148 rounds per gun with the horse artillery equipment, and 100 rounds per gun with the field battery equipment, and that in each case it will be convenient to carry one-fourth part actually with the guns. Continental powers have gone far beyond us in the construction of carriages and limbers, and their latest improvements in these respects have admitted of $\frac{1}{3}$th of the total weight of the equipment behind the splinter-bar being ammunition: let us adopt this proportion as a basis to determine the possible weights of metal we may expect in our future guns. In the light equipment, therefore, we shall have the $\frac{1}{3}$th of 37 cwt., or say 520 lbs. available for ammunition; and in the field batteries the $\frac{1}{3}$th of 50 cwt., or 700 lbs.; thus in the former case we should have 36 rounds of about 15 lbs. each, in the latter 25 rounds of 28 lbs. each. Thus, with due regard to a suitable and therefore heavy charge of powder, we cannot expect to fire a heavier projectile than one of 12 lbs. from the horse artillery gun, and one of 20 lbs. from the field battery gun.*

Muzzle velocity is the great desideratum

6. It is true that Krupp† has produced a gun, the equipment of which is nearly 3 cwt. less than that of our 16-pr., which fires a 27 lb. shell with a muzzle velocity of 1440 f.s.; but, on the other hand, the French 12-pr. has a muzzle velocity of 1600 f.s., and the new Vavasseur 13-pr. one of 1900 f.s. Muzzle velocity governs flatness of trajectory, and as this is of the greatest importance, rendering, as it does, time shells effective at increased ranges, and checking the tendency of percussion shells to bury themselves in the ground on impact, we must not sacrifice it in any great degree to increase the weight of the shell; for a consideration of the tactical duties of artillery will show the low *relative* value of a large bursting charge as compared with high velocity. It also appears that two ammunition wagons per subdivision are required to carry a sufficiency of ammunition with the Krupp gun. In spite, therefore, of a comparatively light 27 lb. having been produced, it will be wiser to keep to the limit of 20 lb. for the projectile, and then, if possible, to increase the powder charge. It may be convenient here to note the proportions between weight of powder charge and weight of shot in various guns, and the corresponding muzzle velocities, remembering always that the energy, or hitting power, of the gun varies as the weight of the shot, but as the *square* of the velocity:—‡

* It is assumed that the question of ammunition must practically decide the weight of the gun, as there does not appear to be much difficulty in the production of the latter within moderate weights; but very great difficulty exists in providing for the transport of the ammunition. Compare also the remarks on this head in the "Mobility of Field Artillery," R. A. I. Proceedings, Vol. IX., pp. 458 et seq.

† See Paper on "Modern Field Artillery," by Capt. James, R.E., R.U.S. Institution Papers, 1880.

‡ Vide tables in "Modern Field Artillery," Capt. James, R.E., R. U. S. Institution Papers, 1880.

	Proportion of weight of powder charge to weight of shell.		
Austrian 10½-pr.	1 : 5	M.V. 1385	f.s.
Krupp 26½-pr....	1 : 4·8	„ 1443	„
German 11-pr....	1 : 4	„ 1525	„
Armstrong 13-pr. B.L.	1 : 3·7	„ 1600	„
French 12-pr.	1 : 3·7	„ 1608	„
Vavasseur 13-pr.	1 : 2·2	„ 1904	„

By the latest manufactures in guns also it has been shown that great increase of muzzle energy can be obtained within the weights of 8 cwt. and 12 cwt. for 12-pr. and 20-pr. respectively.

The gun of position.

7. With regard to the gun of position, there at present exists no model of what modern science can achieve, nor is it easy to lay down any limit with regard to the maximum weight of equipment. We know that 18-prs. were used in the Crimea, and that the weight of this gun alone, without its carriage, was 32 cwt., and the carriages and fittings of 25 years ago were very cumbrous according to our present ideas. The 40-pr. M.L.R. gun, carriage, and limber, with 18 rounds, weighs about 88 cwt., and, as we have seen, 12 horses are supposed to transport at a walk 103 cwt.; it therefore does not seem too much to expect that we can now produce a B.L. gun that shall fire a 50lb. projectile with a high velocity, and that its equipment will admit of its being brought into the field. In guns of this kind, flatness of trajectory is just as essential as in the lighter patterns, and this we would assert in spite of all that has been urged in favour of howitzers, since the experience of Plevna opened up a new line of thought. "We must not expect to find a Plevna in every campaign," and if a campaign is going to assume the appearance of a siege, or a succession of sieges, then we must draw upon the siege train for our weapons; but the field artillery should be equipped on the broad basis of the experience of European warfare, and this does not point to the re-introduction of the howitzer for field purposes. If we consider the tactical requirements of artillery, we will admit that the chief opportunities for high angle fire would be in the preliminary stage of the attack of strong earthworks, woods, or villages; but we must remember that field guns can apply this mode of fire, if necessary, and common shells of *improved pattern* of 30 lbs. or 50 lbs. weight would be found sufficient for all ordinary emergencies.

With an improved armament, moreover, we might expect to effect something against field works by direct fire. Nearly 20 years ago a 40-pr. shot penetrated 14 ft. into clay at a range of 1060 yds, with a charge of 5 lbs., and a muzzle velocity of 1180 f.s., and in November, 1879, the experimental 13-pr., with its service charge, at a range of 1090 yds., penetrated 3 ft. into a target of "concrete wall 3 ft. thick, 6 months old, face of wall 66° to line of fire." It, therefore, is not impossible to oppose any field work likely to be constructed on the field of battle by *direct fire*, with the one exception of *blinded cover*, against which high angle fire must be used, and for this purpose, as before stated, the ordinary gun with a reduced charge is available.

We will, therefore, conclude this portion of our subject by stating that the heavy or position batteries should consist of 50-pr. B.L. guns, but we will refrain from entering into any details with respect to the weight of their equipment, as we are without any data to guide us.

8. The guns for the 3 equipments would therefore be as follows:—

Horse Batteries	12-pr. of 8 cwt.
Field "	20-pr. of 12 cwt.
Position "	50-pr.

We now proceed to the discussion of the general equipment in detail.

The gun.

9. In the manufacture of the gun there appears to be no great difficulty, as the various methods employed by different manufacturers give satisfactory results, strength to fire a heavy projectile with a heavy charge being obtained within a reasonable weight; but, as is well known, a light gun entails a heavy carriage, and *vice versâ* (*i.e.*, the *system* must possess a certain weight), and as weight in the gun is useful weight, enabling a heavy charge of powder to be employed, and weight in the carriage useless weight when once a sufficient strength has been obtained, it seems desirable only to decrease the weight of the gun to that point which will leave the carriage weight enough to properly fulfil its functions. As examples of weight usefully and wastefully employed we may note the two following guns:—

	Weight of Gun.	*Weight of Carriage.*	*Ratio.*
English 9-pr. of 6 cwt. ...	... 672 lbs.	... 1372 lbs.	1 : 2
Krupp 9·6^{cm} B.L.	... 1375 „	... 1288 „	1·3 : 1·2

Advantages of B.L. guns.

10. England is the only country in Europe that has not adopted a breech-loading system, though, doubtless, this reproach will soon be removed from her. Breech-loaders have successfully withstood the test of war, and this is the best answer to those who would insinuate that their construction entails delicacy and weakness. The new features of gun construction, namely, increased length and enlarged powder-chambers, and the choke at the end of the bore, all point to the superior convenience of breech-loaders, especially in gun-pits and entrenchments. With them a complicated gas-check is unnecessary, and now it can be no longer claimed that the muzzle-loader permits the use of a more simple fuze. With a breech-loader there is no fear of a jam, nor of sparks remaining in the bore; it is not necessary to serve the vent, a duty that is sometimes difficult;* a projectile of larger diameter than the bore can be used, better centring and accuracy being thus obtained, and shields can be employed to protect the gunners. The newest breech-loading apparatus may be roughly divided into two classes, the one consisting of a wedge sliding in and out at an angle to the bore (Krupp, Vavasseur, and Whitworth), the

* Vide "Professional Notes," by Lieut. G. R. Slade, R.H.A. R.A. Institution Papers, Vol. XI., No. 4.—"On two occasions the guns became so heated that water had to be thrown upon them to admit of the vent being served."

other of a solid breech-piece that slides in and out parallel to the axis of the gun, being fixed in its place by the use of an interrupted screw (Eastman, Armstrong, French Government). Now, it is stated that all these systems and their modifications are capable of closing the breech in a reliable manner, but the Krupp system has had a much more extended trial than any other, having been employed in two great campaigns, viz., that of 1870–71, and that of 1876–77, and we should have a very good reason for adopting any other than the one that is ready to our hand with such a tried reputation.

Carriages.

11. Carriages will in future, doubtless, be made of steel, and the Whitworth "fluid-pressed steel" appears the best that can be obtained.* "This steel is submitted to great pressure while in a fluid state, thus ensuring perfect soundness and homogeneity; it is afterwards forged by hydraulic pressure; its characteristics are soundness, strength, and ductility."

Means for checking recoil.

12. Excessive recoil is one of the evils that unavoidably result from the use of high charges, and in the Engelhardt carriage an attempt has been made to construct an apparatus that will absorb a portion of the recoil. This apparatus is a hydraulic buffer with which the gun and upper portion of the carriage is connected, and which receives the shock of discharge before the same is communicated to the lower parts of the carriage and the wheels. This carriage weighs about 2 cwt. less than that of our present 9-pr., and is now under experiment. It is also stated to have been most successfully tried in Russia, and in that country it is now regularly adopted for all field guns. If we do not adopt a carriage of this sort, we are thrown back upon the use of a brake, and a brake is very prejudicial to the carriage. The self-acting brakes attached to the carriages of the new 13-pr. are not, it appears, satisfactory, and from their sudden and immediate action, moreover, they are more likely to strain the carriage than one of more gradual action.† Such a brake is shown in Plate III., Fig. 1.

See Note A.

Axletree boxes.

13. The axletree should be provided with boxes, the lids forming seats, as in our present equipment: by careful manufacture we might still hope to carry four complete rounds of even 20-pr. ammunition in them: two additional rounds on the trail would make up the very desirable quantity of six rounds to be carried actually on the gun.

The wheels.

14. Our wheels are the largest in Europe, and the diameter of the wheel has a direct bearing upon the weight of the carriage, and it is open to question whether this diameter could not be decreased to a point that would not seriously affect mobility, but somewhat decrease the weight of the carriage. Thus, the diameter of the Russian and German gun wheels are 5 ins., the Austrian 6 ins., and the Italian 10 ins. less than ours. However, without imitating the Italians in this matter,

---

* Vide Evidence given before Privy Council, Nov. 1879.

† Vide "Short Notes on the 13-pr. M.L. Gun." Major Nicholson, R.H.A. R. A. I. Papers, Vol. XI., No. 2.—"During fire it (the brake) requires constant attention, and the drag-shoe will often be found more certain and less troublesome."

we may, perhaps, admit that their arrangement of the spokes of the wheel is a good one, by which it is provided that the lowest spoke shall be vertical in that wheel upon which the greater strain is thrown; as, for example, on a sloping road, the lowest spoke of the lower wheel would be vertical.

The trail.

15. It would be well if the trail were fitted with a box to carry ammunition, the lid of which would form a seat to be used upon an emergency; thin plates of metal being used in the construction of this and all other ammunition boxes; an iron handspike should be permanently attached with provision for the application of the wooden spare one carried underneath; the trail hook in use with the Italian gun is worthy of notice,* admitting as it does either of a rigid or loose connection between the limber and the carriage; the former being admissible on good ground, the result being less weight on the horses, the latter being only necessary when moving over rough ground. Should we adopt pole draught this would be more than ever desirable.

Elevating apparatus.

16. The length of the guns we are now likely to have render it necessary to "elevate" before limbering up, and it is desirable that little time should be lost over this operation. The elevating arc fitted to the new 13-pr. works quickly, but it is liable to go out of order,† and does not seem to bear rough usage. The double elevating screw in use in Austria is simple and quick in action, and appears well worth a trial.‡

Shields.

17. It is also imperatively necessary that the gun should be provided with a shield to afford cover to the gunners; it has so often been brought forward, and its necessity is so evident, that it is strange no steps have been taken in the matter, and it hardly is necessary to refer to our latest sad experience at Ingogo in South Africa, where it was "death to stand up beside the guns," to emphasize this necessity. Three years ago the question was mooted by a writer in the "Nineteenth Century" from a practical point of view; but the idea has often cropped up under various forms, and is as old as 1444, in which year the gallant Swiss gunners of Bâle held their own against seven-fold odds, being protected by wooden shields fixed on to the gun carriages. In Plate I. is shown a shield upon a machine gun, which is constructed so as to fold up and afford seats for two gunners. A steel shield capable of resisting a Martini-Henry bullet, fired at a range of 100 yds, would weigh under $1\frac{1}{2}$ cwt. It seems useless to insist on the use of these shields, the subject has been so often treated;§ we all know the terrible losses suffered by the Prussian Artillery in their chivalrous support of the other arms in the contests round Metz, and it is a

---

* Vide Dr. Beckerheim, "Field Artillery of Austria, Germany, Russia, Italy and France," p. 48.

† Vide "Short Notes" on the 13-pr. M. L. gun, by Major Nicholson, R.H.A.

‡ Vide Dr. Beckerheim's "Field Artillery," p. 9.

§ Colonel Brackenbury in "Nineteenth Century," 1878. Gold Medal Prize Essay, R.A.I., 1878. Silver Medal Prize Essay, R.A.I., 1879. Major Nicholson in "Short Notes," R.A.I. Papers, Vol XI., No. 2.

matter of common sense that artillery to be really effective must be independent of natural cover, often having to act where none such exists, and at the same time the improvements in small arms, and the development of long range fire are tending to render the service of guns in the open almost impossible. It would be well for us to lay aside any presumptuous ideas we may have imbibed from the experience of the practice ground, and turn to the consideration of the stern facts of history, and to remember that our field artillery is absolutely without reserve upon which it can fall back. It is to be hoped that this question will soon meet with the attention it deserves.

The limber.

18. The limber should be made principally of steel, with thin plates of metal where necessary; the use of buffers as introduced into the Russian Artillery is manifest; in that service* the "limber frame is made of iron bars, and so connected with the axle that above the prismatic axletree (B) there is a support provided with a slit, which is connected with the caoutchouc buffers (C), which are under the axletree; by this means the shocks upon the axle are borne by the buffers, and only received by the limbers in greatly decreased force." The limber should have but one box, provided, where necessary, with thin metal plates. The system of having drawers in the limber containing the projectiles has serious drawbacks, such as liability to jams, &c., and if it was placed on the slope of a hill, a very common occurrence, the service of the ammunition would become impeded; such a system would also render difficult the adoption of some means to protect the men and horses with the limber; that something of the kind is necessary is amply proved by the casualties in the gun teams during the Franco-German war,† a great many of which must have occurred whilst the batteries were in action; if the limber were reversed in action, so that the horses heads would be turned to the rear, and if the lid of the limber box were made bullet proof, a good deal of protection would be afforded, but it would be well if in addition folding screens were provided that could be extended at will, a little over the wheels. In the service of the ammunition one gunner would remain mounted on the limber, and the hinges of the lid of the box would be to the rear, that is, over the pin-tail. As doubtless all projectiles in future will be carried with fuzes fixed, it is desirable that they should be shaken as little as possible during transport. The buffers above referred to will facilitate this; in addition, we would propose the following mode of packing:—the projectiles should be placed parallel to the longer sides of the box, and four pieces of metal (*aa*, *bb*, *a'a'*, *b'b'*,) should be provided to keep them in their places, of these *aa a'a'* should be fixed, a play of one inch being allowed to *bb*, *b'b'*, by means of slots at *c*, *c*, *c*, *c*. Four bars *d*, *d*, *d*, *d*, would supply the means of screwing up *bb*, *b'b'*, close to *aa* and *a'a'*, and when this was done the circular opening left in the metal should correspond exactly to the calibre of the projectiles, and the curved portion of the metal should be faced with gutta-percha.

See pl. III., fig. 3.

See pl. III., fig. 4.

See pl. III., fig. 2.

---

* Vide Dr. Beckerheim's "Field Artillery," p. 61.

† Vide Hoffbauer, "The German Artillery," Appendix.

The bars should be screwed in tight on the march or during movement, but should be loosened by a key provided for the purpose as the gun was halting previous to unlimbering; there should also be a recess, provided with a washer, to receive the base of each projectile, and there should be two cartouches with each limber for the purpose of carrying, if necessary, several rounds at once to the gun.

The supply of ammunition.

19. The remaining carriages of the battery are so intimately connected with the ammunition supply, that it is necessary to discuss the relation of the latter to them. The mode laid down in our drill book for the supply of ammunition in the field is hardly suitable under a heavy fire; that the German system was imperfect a glance at the war of 1870–1 will amply show, and it is to the cumbrous ammunition wagons, we think, that this failure may be fairly attributed, and indeed it seems absurd that any carriage which is not supposed to be taken at a gallop should have to go under fire; and as ammunition will probably be in future much heavier than it is at present, the giving up of the wagon will almost be forced upon us.

See Note B.

The modified limber system proposed by Lieut. Goold-Adams.

20. It seems a practical proposal to substitute two limbers for the wagon, these limbers to be larger than the gun limbers, but suitable, if necessary, to be used in place of them*; in the horse batteries the front line of these limbers would have teams of four horses, the second line teams of two; in the field batteries both lines would have four horse teams. The number of horses at present allowed would therefore not be exceeded. Then in case the ammunition in the gun limber were expended, an ammunition limber of the first line should be sent forward at a gallop to take its place, the gun limber retiring also at a gallop to where the limbers of the second line were placed out of fire, there to be re-filled, after which it would return to its gun.

Proposed ammunition wagon.

21. For use in the ammunition columns a wagon might be adopted which should consist merely of a framework on wheels, fitted to carry a certain number of boxes, capable of sliding on and off in the same manner as our present limber boxes do, these boxes should correspond exactly to those of the ammunition limbers, so that when one of the latter became empty, it could be removed from the limber, placed on the wagon, and a full one fixed in its place. The Divisional Ammunition Columns, which as a rule will be close up to the front, should mainly consist of ammunition limbers, but an arrangement could be made by which two of these could be locked up together, so as to form one four-wheeled carriage; the ammunition wagon would be found principally in the Army Corps Ammunition Column, and to prevent mistakes it would be advisable to adopt a different colour for the carriages, &c., appertaining to the different kinds of guns.

Spare wheels.

22. The spare wheels could be carried underneath the ammunition limbers on a similar plan to that in use in Austria†.

---

* Vide R. A. I. Prize Essay, 1879.

† Vide Dr. Beckerheim's "Field Artillery," p. 11.

Ammunition wagons to be kept distinct from store wagons.

23. Ammunition wagons should be kept distinct from store wagons, and whenever it is possible draught horses should be driven from a box, and not ridden.

The forge.

24. There seems no pressing necessity for a *very light* field forge; when the present type was introduced it met with much unfavourable criticism, but it seems extremely unlikely that a forge will be often required to leave the roads the trains move upon; it therefore is wise to utilize the forge wagon for the conveyance of stores, and the weight of the latest pattern (45 cwt.) is not excessive; it is doubtless a great advantage to do away with the cumbrous bellows, and no doubt a further reduction in weight could be made by the substitution of metal plates for woodwork, and by utilizing steel for axletrees, &c.

Pole draught.

25. Pole draught should be adopted throughout the service; we in England stand alone in using shafts, the main advantages of which are that the carriage is more under control for turning and manœuvring, and that a pole is liable to bear down upon the wheelers' in going down hill, or in crossing irregularities of ground. In favor of the pole, it may be urged, the work is equally divided amongst the team; in stopping the carriage or in going down hill almost all the weight is not thrown upon one horse; we cannot on service expect to keep up a supply of the fine animals at present seen in the shafts, and the horses we should have to fall back upon are all likely to have been accustomed to pole-draught in double harness. A lighter style of harness can be adopted, and it all can be made interchangeable, a matter of the greatest advantage in case of a casualty to a wheeler. The loss of time that at present would be incurred in replacing a wounded wheel horse might be fatal, whereas in the case of pole-draught the gun could proceed drawn by the lead and centre after little or no delay; with pole harness moreover it would be much easier to extricate a fallen wheeler than at present. The spare poles, one of which should be on every carriage, should be made in two parts, capable of being jointed together.

Entrenching tools.

26. The number of spades and shovels carried by the battery should be doubled; they could be carried as now but strapped together in pairs.

The harness.

27. The harness, as before stated, should be made much lighter and perfectly interchangeable. Our present saddles are extremely heavy: an equipment which had an extensive trial in the American war is much lighter; the saddle has a light iron tree with unstuffed flaps, and fits over a large felt numnah; the side bars of the saddle are also unstuffed; the "colonial" girth of twisted leather thongs should also be introduced. Breast harness on the riding horses should be abolished, it is altogether useless and apt to gall the horses shoulders even when not in use; lasso equipment should be substituted.

Picketing tackle.

28. The leather picketing shackle is very heavy, and but few horses, attached to a picket line as artillery horses are, would require it after the first few days of a campaign; it should therefore be lighter and

made of soft leather, to be kept well dubbed, and should fit *above the fetlock* with a leather button and loop; the risk of having a large number of sore heels at the outset of operations would thus be avoided.

The valise.

29. The valise, which may be a necessity for cavalry, from the necessity of having to ride at times "jammed boot to boot," is by no means so for the Artillery, and is a most inconvenient way of carrying a kit: moreover if packed by an unskilful man, it is very apt to gall the horse. For Artillery purposes therefore we would recommend to replace the valise a pair of waterproof canvas saddle bags, made out of the material generally used for gun covers, game bags, &c; the drivers kits would of course be placed as now on the off horse, but the bags could be hung in such a way as to admit of a man being mounted if necessary.

Ammunition

30. It seems to be recognised by the European powers that it is desirable to have both a *time* and a *percussion* projectile; we however have considered that the shrapnel shell can fulfil both purposes; it seems open to question if we are right, as the properties of a good time shell are somewhat antagonistic to those of a good percussion projectile; for example, in the former the bursting charge should be a minimum, in the latter a maximum. It will therefore be here assumed that the chief *rôle* of a shrapnel is that of a time shell, and that it is necessary to provide some form of double-wall, ring, or segment shell in addition thereto.

The shrapnel shell.

31. There can be no doubt that our present shrapnel shell has great defects, which are aggravated by the wooden time fuze we employ. Indeed this has been some time recognised, and lately the Armstrong Company have introduced a shell which has been already tried, and found vastly superior to the present pattern. The body of the shell is made of steel, and is closed at the base by a wrought iron disc; the bursting charge is in the head of the shell, and the central column is thus done away with; for the sake of comparison some other shrapnels are shown in Plate IV. It will be noted that in the Italian shrapnel the bursting charge is in the centre. As the effect of the shrapnel shell depends upon the velocity of the bullets when released, and as this depends upon the remaining velocity of the shell, it follows that the latter should be as little interfered with as possible by the bursting charge, which is always calculated to be just sufficient to open the shell. Now if the bursting charge is placed in the head of the shell it will tend to check the bullets, and though at ordinary ranges this bad effect will be small, at long ranges, when the remaining velocity of the shell will have greatly diminished, it may be distinctly felt. One of the most useful results of the present high muzzle velocities obtainable from field guns is the increased range of the shrapnel shell, which can now be made effective beyond 3000 yds., and we should carefully guard against anything that in the least interferes with this. The bullets also are the principal part of the shell, and the greater their number and weight the better; thus, in our 9-pr. shrapnel the weight of the bullets is to the weight of the shell as 1 : 4, while in the German

See pl. IV., fig. 4.

12-pr. this ratio is 1 : 2·7. Steel has been already introduced for the body of the shell, and if the latter were cast with longitudinal ribs the envelope for the bullets might be made very thin. A fuze in the base of the projectile would also be a desideratum, as doing away with the central column and allowing the projectile to be cast with a point. When experiments cast more light on the use of guncotton, it, or some kindred explosive, will be used as the bursting charge of all shells. Powder chambers about $\frac{1}{3}$ or $\frac{1}{4}$ the present size will then be used, and thus more space for bullets will be obtained.

Proportion of shrapnel to be carried.

32. To determine the proportion of shrapnel we should carry, it will be necessary to consider its use and effects, and the same course will be followed with the other kinds of projectiles as we come to them. Against troops in the open there is no projectile that can compare with the shrapnel shell, the depth of its cone of dispersion being admirably adapted to repel the present deep attack formations, and to enfilade defensive lines; but when an enfilading fire cannot be brought to bear it is not very effective against entrenchments; against field-works, woods, and buildings it is comparatively useless, and it is not in the nature of a time shell to use it with a reduced charge for indirect fire. If then we consider this projectile with regard to the tactical duties of Artillery, we will find that it is not suited to the *preliminary stages of the attack*, except in the two following cases:—(1) When it is possible to enfilade the defensive lines or to cross the fire of two flanks, as, for example, at Mars la Tour, where the "German Artillery of the right flank supported the Infantry of the left, and the Artillery of the left helped the troops posted on the right*," and (2) when the presence of troops on the reverse slope of a hill is communicated to the battery. The frontal and direct attack of troops holding a defensive position would as a rule be ineffective with this projectile. In *supporting the attack* however, when the defences would be somewhat broken down, and in *repelling counterstrokes* the shrapnel would be unrivalled. On the *defensive* in all its stages it would probably be the most useful projectile, as also in *pursuits* and *retreats*, but it is doubtful if another class of projectile would not be more effective in the case of *advanced guards*, and also on ordinary *detached duties*.

Percussion shells.

33. A percussion shell should have a strong bursting charge, but if much explosive power is required, the room left for rings, segments, &c., (which go to increase the number of *dangerous fragments*) is very much diminished. Projectiles of field artillery should however be designed with a view to man-killing power; high explosive effect—difficult to get—should be specially provided for; the necessity for it is also much reduced by the high penetrative power likely to be attained by modern field guns. It however cannot entirely be dispensed with, and we would therefore divide percussion shells into two classes, viz., (1) Segment shells, (2) Explosive and Incendiary shells—we will avoid the use of the term "common shell" as is it is liable to be misunder-

---

* Vide Hoffbauer.

stood, and "segment" must be taken to mean some form of segment, bullet, ring or double-wall shell.

34. On the Continent the double-wall shell is giving way to the ring segment shell: the former is not found in the equipments of Austria, Russia, or Italy, and it will doubtless soon disappear from those of France and Germany. The ring shell indeed reminds one somewhat of our own segment shell which invented to fulfil a too ambitious *rôle*, and wedded to a fuze totally unfit to display its best effects, has been somewhat hastily hustled out of the service, though most of the reports on it in actual warfare have been favorable*. It appears very desirable to give this kind of shell a pointed head, which might be hardened or cast in chill to enhance its penetrative power; indeed from a 50-pr., constructed according to modern ideas, very great penetrative powers might be expected, when a segment shell from the old 12-pr. B. L. (with a muzzle velocity of 1239 f.s.) gave "good results when used against troops behind a thin wall." There is however one drawback to the sharp point:—if the shell is fired at long ranges against troops it has a tendency to bury itself in the ground; this is counteracted in some degree by the flat trajectories we can now obtain, *e.g.*, the angle of descent of the present 16-pr. at 2600 yards is 8° 38′, while that of the new 13-pr. at 2600 yds. is 7° 2′, and that of the Russian 12-pr. 7° at 2330 yds. This tendency, it may be remarked, renders our present shrapnel shell a very unsuitable percussion projectile, as the bursting charge in the base would be calculated to drive the bullets into the ground. It thus appears desirable in a percussion projectile to have a preponderance of the bursting charge in the head. If then we take the Austrian ring shell (Plate IV.) as a basis to work upon, if we gave it a steel body, a pointed head, a guncotton burster, and an additional column of segments, we arrive at the result shown in Fig. 5. The size of the segmental rings (or annular segments) is somewhat diminished, but this could be compensated for by using in their construction a heavier metal than cast-iron. Instead of a shell of this kind, experiments might point to the adoption of a bullet shell (something similar to the Italian shrapnel) as our percussion projectile, the spherical bullets being calculated to range further than the segments. A fuze in the base of the projectile would be necessary with this shell.

The annular segment shell. *See pl. IV.*

35. Such a projectile would be of the greatest use against the defenders in the *preliminary stages of the attack*, to be used with full charges against earthworks, walls, buildings, and shelter trenches, and with reduced charges to search out hollows and bombard villages and woods. Doubtless, if the country were open, time-shrapnel and case would be the only projectiles used on *the defensive*, but cover of some sort always exists, and, where cover is, the percussion shell at once comes into play. In all the *minor operations of war* opportunities for its use would constantly arise. These facts are recognized by the continental powers that have recently revised their ammunition equipment,

Proportion carried of annular segment shell.

* See "Treatise on Ammunition," under heading "Segment Shells," pp. 148 & 297, et seq.

and have their practical results in the proportions carried of the different kinds of shell. Thus, with the Austrian horse artillery gun, there are 102 annular segment (percussion) shells and 36 shrapnel (time). With the German horse artillery gun there are 104 of the former and 44 of the latter; with the Russian gun there is an equal quantity of both; if these countries, however, based their equipment on the results of the practice ground a different proportion would have been adopted. It may be observed that in the war of 1877–78, the *See Note C.* Russian artillery fired very nearly three percussion shells for every single shrapnel.*

Explosive shells.

36. We now come to the consideration of the second class of percussion shells, viz., the explosive and the incendiary shell. The presence of extensive and strong field-works will always necessitate the use of a common shell, properly so called, but, as before stated, we will avoid this term, and for want of a better we will speak of a shell, the main effect of which is due to its bursting charge, and not to the number of dangerous splinters it gives, as an *explosive* shell. Now, we are told that the bursting charge of the 13-pr. common shell, though comparatively large (10 oz.), gives little or no useful result.† Recent experiments seem to show that there may be a possibility of firing a shell full of guncotton or some other kindred explosive with safety, and this, no doubt, will be a solution of the question when it is definitely proved that full service charges can be employed. The body should be made of steel, strengthened with longitudinal ribs, and thus increased capacity would be obtained which, in addition to the more powerful nature of the burster, would tend to produce a really effective projectile. The head should be pointed, and the fuze should be carried in the base. This shell would be used against strong earthworks and blinded cover, and would probably be suitable for the *preliminary stages of the attack*, and for shelling villages, abattis, obstacles, &c., at all times.

Incendiary shells.

37. Occasions might arise where an incendiary shell would be a very desirable projectile: it would, however, be inexpedient to further increase the different kinds of projectile composing the ammunition equipment; it would therefore be well if the explosive shell could be used for this purpose by altering the bursting charge, and experiments in this direction, resulting in the star shell, have been successfully carried out. It is a question, however, if this projectile is as efficient as the Austrian carcass, but by its use the inconvenience of *See pl. IV.* a different form of shell is avoided, and the empty envelopes of the explosive shell could be filled, at the base or other important ammunition station, with guncotton pulp or combustible stars as occasion demanded. Incendiary shells would be chiefly used against buildings or any inflammable cover, natural or artificial, woods, and abattis.

Case shot.

38. Our case shot is, doubtless, capable of great improvement.

---

* Vide R. A. I. Papers, Vol. XI., No. 5, p. 372.

† Vide Major Nicholson, R.H.A. "Short Notes on 13-pr"

Experiments have been carried out to see if the use of gas-checks would increase its effective range, but the results so far have not been very definite. The Austrians consider that their 9cm gun can fire case with good effect up to 700 yds. The Italian limit is about the same, while that of Germany is 470 yds. The weight of the bullets may have something to do with this; thus, the weight of the bullet in our present case shot is under an ounce (that for the new 13-pr. is under half-an-ounce), while in Austria this bullet weighs 1·6 oz., and in Germany, for the field battery gun, 2⅓ oz. There is also a peculiarity about the form of the case used in those countries (see Plate IV.) It therefore appears that, by increasing the weight of the bullets and somewhat altering its form, we can render case shot efficient up to, say, 500 yds. From 500 yds. to 800 yds. shrapnel, with the time fuze set to zero, can be employed. The days of case shot have by no means gone by: from Zululand and Afghanistan we have heard many favourable reports of its use,* and in European warfare it has not been discarded. In the Russo-Turkish War, on one occasion, it saved the guns,† and the number of rounds expended during that campaign (585) might possibly point to the desirability of carrying more than four case shot per gun; our own experience in Afghanistan and the Cape points to the same conclusion, and, no doubt, in such wars as those above referred to, a greater number might be carried; but for our ordinary equipment, based, as it should be, on the experience of European warfare, it would be well to abide by the teaching of the Franco-German war, bearing in mind that the Germans had few shrapnel and no machine guns. Thus we read that at Mars la Tour "swarms of skirmishers again rushed out from Vionville, and the moment became critical; the battery had recourse to case, and succeeded in driving the enemy back into the village;" ‡ and again, that at Gravelotte: "In this battle, also, we find case shot employed in self-defence."‡ Thus there is no doubt about the necessity of having case for an emergency; but if we refer to the number actually expended, we will find that at Mars la Tour it was 19, at Gravelotte, 20. Total 39.‡ We therefore think that four rounds per gun is ample.

Proportions recommended to be carried of the various projectiles.

39. Taking into consideration the results arrived at in the foregoing remarks, we would recommend the following proportions of the various projectiles to be carried by each sub-division of the three different batteries referred to:—

	Horse Artillery.	Field Battery.	Position Artillery.
Shrapnel	67	42	20
Annular Segment	67	42	15
Explosive	10	12	15
Case	4	4	2
Total	148	100	52

N.B.—The case shot would always be carried on the gun, together with two rounds of shrapnel, to avoid delay in opening fire.

* Vide Blue-Book on War in Afghanistan. Report of O. C. "A" Batt., "B" Bde., R.H.A.; also Slade's Journal in S. Africa, R. A. I. Papers, Vol. XI., No. 4.

† Vide "Russian Artillery in War of 1877-8," R. A. I. Papers, Vol. XI., No. 4.

‡ Vide Hoffbauer.

Cartridges. 40. For the purpose of firing with reduced charges, 20 per cent. of the cartridges might be made up in the following manner:—A certain portion of the service charge will be enclosed in a papier-mâche cylinder in the body of the cartridge; if a reduced charge is required, this cylinder must be pricked with a pricker provided for the purpose, and the powder contained in it shaken out; if this is not done, the cartridge can, on an emergency, be used as a service charge.

Percussion fuzes. 41. The fuzes of the future will, doubtless, admit of being carried fixed in the shells; it also seems desirable that they should be attached at the base of the projectile, especially in the case of the percussion fuze.* A fuze of this description was last year patented in this country, but, as far as we know, it has not as yet had an extensive trial.

See Note D.

Time fuzes. 42. Our present type of time fuze may be said to be already condemned. "Progress in fuzes seem to point in the direction of a combined time and percussion fuze, so as to ensure the shell acting on graze, if not before. Such fuzes are now in use in the French and Swiss artillery, and other nations, including ourselves, are experimenting in the same direction." † Time fuzes should be carried fixed, they should be minutely graduated, the operation of setting should be simple and speedy, and the fuze should admit of being reset if correction were necessary; they should be graduated in yards in such a way that the shell should be timed to burst at the proper distance short of the range actually marked upon the fuze; they should be fixed in the base of the projectile, as the composition would be more likely to burn regularly in the vacuous space behind the shell, which could be made pointed, and, if necessary, they could be used with the explosive shell against thick earthworks or blinded cover, where the operation of the percussion fuze would be too rapid. That metal fuzes are more expensive than wooden ones should be no excuse for the existence of the latter, which, though trustworthy enough when new, are very liable to deterioration, and take up a great deal of room in the shell. The introduction, as has been proposed,‡ of some chemical compound instead of a mechanical mixture for the fuze composition would also have the desirable result of ensuring greater regularity in burning. Metal fuzes also admit of much finer divisions being made in the fuze composition; they would, after a stated time, be recalled into store and re-driven, the metal cases being available again and again, and it should be a *sine quâ non* that every battery should be provided with a thoroughly trustworthy fuze equipment.

Friction tubes. 43. Our present friction tubes appear to deteriorate from damp and the shaking of the limbers, and an improvement in future manufacture has already been decided on; but the projecting friction bar will still exist,§ and it will always be a source of weakness, and an impediment

* Vide Specification, No. 4172, 15th Oct., 1879.

† Vide "Modern Field Artillery." Capt. W. James, R.E.

‡ Vide "Modern Field Artillery." Capt. W. James, R.E.

§ Vide Changes in War Material, No. 3482.

to satisfactory and close packing. The one in general use abroad is simpler and stronger. It consists of a copper tube, closed by a wooden disc, beneath which is the friction arrangement, and through which the friction wire passes. It is easily packed and is more impervious to damp than ours, as the tube is more effectively closed.* *See pl. IV., fig. 1.*

44. There should be two sights per gun; one graduated to about 3000 yds., of the pattern issued with the new 13-pr., provided with FitzRoy's deflectors and the means of fine laying. It should be triangular in section; on the right side should be marked the range in yards for the shrapnel and annular-segment shells (which should be equalized in weight), on the left for the explosive and incendiary shells (also equalized in weight). To prevent mistakes, the latter graduations should be in red. On the third side degrees and minutes should be shown. For use in conjunction with this sight a small telescope should be issued to the Nos. 1 for the purpose of either watching the effect of a shot, or reconnoitring a target before firing.† Sights.

45. The second sight should be telescopic, and graduated up to the extreme range of the guns. The necessary frangibility of this sight will render its carriage difficult, and it will perhaps be most conveniently placed in a leather case to be strapped to the No. 1's saddle. That the production of a good telescopic sight is quite feasible, the Report of the French Committee on that proposed by Capt. Scott, R.E., amply proves, but whether the sight in question is the best we can obtain remains to be seen; it is however "surely within the bounds of optical possibility to construct a telescopic sight that shall fulfil the required conditions of service‡." Telescopic sight.

46. We have now discussed *seriatim* the various articles of equipment that go to make up the weight drawn by the team, but before we proceed to discuss the effect the various alterations would have on the total load, it will be necessary to touch upon one other subject as it also materially bears upon the case. The necessity for high stature is much more pressing in the case of a driver who may perhaps have to saddle a horse 17 hands high than in that of a man who has to work a field gun, and *weight* may be said to vary directly as stature; yet we insist upon our gunners being so much taller than our drivers; we would recommend that short men with good chest measurement should be chosen as gunners, and that those of field batteries should be taught sufficient riding drill to enable them to drive on an emergency just as at present our drivers are supposed to know enough gun drill to enable them, if required, to take their place in the detachment. As we have said weight varies as height. If therefore 10-st. men were carried in place of 12-st. men § in a field battery equipment, the saving would be 140 lb., *i.e.*, about the weight of a gun-shield. Moreover, by Short gunners.

* Vide full description in Dr. Beckerheim's "Field Artillery," p. 13.

† Vide R. A. I. Prize Essay, 1880.

‡ "Modern Field Artillery." Captain W. James, R. E.

§ The present weight is put at 12-st., as that is the weight generally assumed in calculations concerning English gunners.

this system and by the adoption of pole-draught a perfect interchangeability would exist between all the horses and men respectively, and on an emergency this might be of an incalculable value.

The question of the total weight of the epuipment.

47. We will now consider how the total weight arrived at satisfies the laws of traction, but we will not attempt to give a detail of weights for the position gun as we have no data to guide us. We will also not take into consideration the saving of weight caused by the adoption of a lighter style of harness, though this would be considerable, as for every 14 lbs. taken off a horse's back, at least ½ cwt. can be added behind the splinter-bar. The weights are as follows :—

HORSE ARTILLERY GUN.

		lbs.
Weight of	gun of 8 cwt.	896
	carriage (same as Austrian H. A. gun) ...	1027
	steel shield	150
	limber (same as Austrian)	1008
	36 rounds	540
	stores	112
	2 (10-st.) gunners	280
	Total	4013

FIELD BATTERY GUN.

		lbs.
Weight of	gun of 12 cwt.	1344
	carriage (same as that of Krupp's 9·6^{cm} gun	1188
	steel shield	150
	limber (as before)	1008
	25 rounds	700
	stores	112
	5 (10-st.) gunners	700
	Total	5202

It therefore seems quite feasible to devise an equipment such as we have sketched out, without offending against the laws of traction.

Machine guns.

48. In addition to the three natures of gun with which we have been dealing there also seems a very important *rôle* to be played by a good machine gun. But in considering this question we must remember that the impending introduction into European warfare of a magazine rifle will greatly develope the fire-power of the Infantry which at present is very great, and may be taken as 30 Martini-Henry rifles=1 Gatling. It may be assumed that with the magazine rifle we should get the same result from a smaller number of men, the loss of any one or any five of whom would not cripple altogether the efficiency of the whole, whereas if we seek to obtain the same effect from a machine, the equipment of which, composed of men, horses and materiel, must be cumbrous compared to that of an individual, we are liable to a loss of the whole effect from an accident to one of the parts. In addition, a machine gun, the range of which is only equal to that of a small arm, can always be effectively opposed by telling off several marksmen to fire at it.

These considerations point to the conclusion that it should partake more of the nature of the cannon than the rifle, that is, that it should possess *ballistic power* and *long range* so as to produce an effect not to be equalled by any number of Infantry rifles. As far as we know there is only one machine gun of this kind in existence, and without asserting that it is the best gun, or the one we ought to adopt, it certainly represents a *system* which for field purposes is as far superior to any other machine gun system as the Martini-Henry is to the Snider.

The Hotchkiss revolving cannon.

49. The gun we refer to is the Hotchkiss revolving cannon, fully described in the Proceedings of the United Service Institution, under date, March 1st, 1880. It has a range equal to that of field guns, and fires an explosive shell ($1\frac{1}{4}$ lb. in weight) with a percussion fuze.* It consists of a group of five barrels which revolve in front of a solid breech-piece; there is only one spring in the gun which is a strong flat one, 80 rounds per minute can be fired, or 60 with deliberation, each shell bursting as a rule into 20 dangerous fragments, "so that a continuous and deadly fire of 75 lbs. of metal or 1200 hits per minute can be produced*;" thus, though the number of dangerous fragments caused by this weapon compares favorably with other systems, the rate of fire is much slower and a *greater effect is produced by a slower moving mechanism,* resulting in great simplicity and strength. In Plate II, all the parts of the gun are shown, there being only 11; for the sake of comparison, Plate V. is attached, showing the 80 parts of which a Gardiner gun consists. The mechanism of the Hotchkiss gun is so manifestly simple, that any trained gunner could work it almost intuitively, and any intelligent man, after a quarter of an hour's instruction, could take it to pieces and put it together again in a few minutes.

50. A jam is almost impossible, if one did occur the system could be righted in a second by moving the crank the $\frac{1}{100}$ part of a revolution the reverse way. Should the point of the firing pin be broken off (as has *once* occurred) it will fall clean through a hole drilled for the purpose, and a new one can be put in in 3 or 4 seconds; there is nothing else frangible in the gun; the extreme range of this gun is stated in the official reports of the French Government to be 5000 mètres, that is, about 5460 yds., up to which range it is stated to have "a capacity for effective fire," it can therefore not be stigmatised as an "incumbrance." In America exhaustive trials were carried out in 1878–79, at ranges from 200 to 2000 yds., and the official report states* "it is evident that the system gives promise of proving a valuable auxiliary to the light Artillery of our service; its *equality* in range, its greater capacity for delivering a deadly, incessant and *wide-spread fire at all field ranges, and with decided superior rapidity,* its stability when fired," (the gun has no recoil) "and its evident superiority in pursuing retreating columns, give it some decided advantages over ordinary field guns." Mere local effect is avoided by means of a traversing saddle, and each round, as has been said, bursts

* Vide "Ordnance Notes," No. 94, Washington, Jan. 15th, 1879 (Official).

into 20 fragments; this fact also admits of the men serving the gun noting whether the proper range is known. As before stated 1200 fragments per minute can be produced. This machine gun has been adopted by Germany, Austria, Denmark, France, Greece, America, Brazil, and Russia for naval purposes, and by the last-named five for military purposes also.

See Note E.

The tactical uses of this machine gun.

51. We consider a weapon of this kind would be a welcome addition to our field artillery, and that its use is evident under the following contingencies:—

Preparation of the attack.—The long range of the revolving cannon would permit of a continuous stream of projectiles being poured upon the points selected for attack; the projectiles acting as percussion shells they lose none of their effect from loss of velocity, and are well suited to search out cover, such as woods, hollows, &c.

Support of the attack.—Here, where the target is less covered, its effect is manifest, and partakes of the nature of that claimed for the ordinary mitrailleur; it is especially suited to repel columns of counter-attack.

Preliminary defence.—Its long range permits it to take part in the general fire; the nature of its projectile renders it very effective against artillery limbers and ammunition wagons.

Final defence.—Its rapid case-like fire is the very thing for this phase of battle.

Its capability for picking out the range by a series of rapid single shots, and then for covering the object with a withering fire when the range is found, renders it extremely useful for *pursuits*, while, in covering a *retreat*, it would have an excellent target in the advancing columns that would probably have to cross the open.

It could act as a rough and ready range-finder, and at times could perform the duties of an escort, and would be available at all times where a fire of "case" was desirable. We are of opinion that two guns of this kind per battery* would be a useful addition to its war strength. By a more judicious arrangement of the horse-holders in the H.A. the necessary horses might be forthcoming for that branch, while, if any additional were needed for these or other batteries, the extra expense would not be worth considering, the gain would be so great.†

Army Corps equipment.

52. We would therefore propose the Army Corps equipment of guns should be increased by 30 machine guns, and 16 of heavy calibre, such as the 50-pr. These last should be formed in two batteries of eight guns each, with an increased proportion of officers. The horse and field batteries would consist, as now, of six pieces, which, on mobilization, would be increased to eight by the addition of two machine guns: the necessary supply of extra subalterns could easily be obtained

---

* Horse and field batteries only.

† The Light Model, as it is called, would be the H.A. gun, the Heavy Model that for field batteries.

by volunteering. We think this increase of 46 pieces quite justified by the late great development of field fortification and infantry fire.

Range finders.

53. Range-finders have been discredited by injudicious praise, and though a most useful and necessary part of a battery's equipment they are not at all times in their place. When ranges are short and fire hot and rapid they are of no good, but it is obvious how, by their use, a battery in position, awaiting the approach of the enemy, could ascertain and note the range of all landmarks in its front, and all the likely artillery positions available for him, so that effective fire could be opened upon him as soon as he appeared. A range party sent on in front of a battery, creeping up to the attack of a position, might also, possibly, ascertain unobserved the distances of various points in the defensive line, so that the moment a battery unlimbered it could open a useful fire, whereas, if the rough and ready way of picking out the range by the burst of a percussion shell were resorted to, a fire at a *known range* would be immediately returned by the defenders' guns, and the attacking battery would probably suffer severely before it was able to effectively reply; other occasions will, no doubt, suggest themselves where a range-finder would be useful; therefore, though the Germans are said to have declared against them, let them by all means form part of our equipment. In an instrument of this kind it seems that extreme *rapidity* is not such a desirable thing as extreme *accuracy*, as the occasions where it can be practically used will admit of a certain amount of deliberation, and, as the distances it will have to determine will generally be long, it should, of course, be telescopic.

Signalling equipment.

54. Though a separate equipment per battery would hardly be necessary on service, still, for instruction purposes, for the production of a number of trained men, and till a corps of Mounted Army Signallers is definitely adopted in the service, it is desirable that a signalling equipment should be issued to each battery. This should consist of a double set of flags and a couple of heliographs; used on service in connection with large scale maps, to be prepared and issued by the Intelligence Department, these would greatly develop the power of the guns. The position of troops, invisible from the battery, could be signalled and indicated on the map, and when fire was opened its effect could, in like manner, be communicated to the guns. Such a mode of procedure might be useful in the attack of a position. The strength of a battery should be increased by a few mounted men who should be trained as scouts, acting as those of a cavalry regiment do; they would also be available as signallers and range-finders.

Mountain equipment.

55. In the new jointed steel 7-pr., we may congratulate ourselves upon having got the best mountain gun in the world: it has a high initial velocity, it is capable of firing a heavy charge, and it has already a good service reputation. It appears, however, that its carriage might be improved, as *wheels* do not appear to be of much use in a mountain carriage.* The gun and carriage, moreover, require five mules for transport. Good as this gun is, therefore, it is possible that there is

* "Vide Austrian Mountain Artillery." R. A. I. Papers, Vol. XI., No. 1, p. 31.

room for one of a lighter description also, thus heavy and light mountain batteries might be organized.

A light mountain gun.

56. For this purpose, a gun that has been greatly used in America is worthy of notice; its weight is only 112 lbs., and it has hitherto been mounted on a travelling carriage weighing 120 lbs.; but this, no doubt, could be replaced by a much lighter one without wheels.* The gun is a breech-loader, and it fires a metallic cartridge which contains *See Note F.* both powder charge and shell, and has a range of 7000 yds. To avoid the risk of having a percussion cap in the cartridge, the gun is fired by a friction tube in the following manner:—The bottom of the cartridge is closed by two metal discs: the inner is shown in Fig. 6, the outer in Fig. 5. In the outer disc is one hole, in the inner there are three symmetrically placed. The gas from the friction tube enters at the hole (*a*) in Fig. 5, and, pressing out the inner disc, ignites the powder by means of the holes (*b*) Fig. 6. When the charge explodes, the inner disc is forced back upon the outer, and the hole (*a*) is closed, perfect *obturation* being thus obtained. The breech is closed by a simple sliding breech-block, and the gun could be served by one man, though three are more convenient. If a carriage without wheels were adopted, two mules could carry the gun, carriage, and 60 or 70 rounds; if a third mule were employed a total of 150 rounds could be carried.

Machine gun for mountain batteries.

57. In mountain equipment there is also scope for a good machine gun, but here *lightness* is a *sine quâ non*, and *power* must give way to it. Without asserting that any one gun is the best for this purpose, we would recommend some such weapon as the Gardiner machine gun, mounted as shown in Plate VI. The weight of the gun and tripod is 201 lbs., and a certain amount of delicacy of construction may be passed over in a mitrailleur for *mountain service* as the mode of carriage protects it to a certain extent from jars and shaking.

Mantlets.

58. Small steel mantlets, say 3 ft. × 6 ft. × $\frac{3}{20}$ ins., which would be easily transported, would be of great service and afford protection from sharp-shooters, and are as necessary to mountain equipment as shields are to a field gun.

Rockets.

59. Rockets are also eminently suited for mountain service; from recent experiments it appears likely that we can obtain a trustworthy rocket with a guncotton head; when this is accomplished a supply should also accompany the Army Corps.

60. Range-finders and signal apparatus would of course always accompany a mountain battery.

Instructional aids.

61. We will close this paper with a few words upon "Instructional Aids," which should form part of the equipment of every battery in peace time, and which would enable the battery officers to impart that information to their men, without which all improvement in guns and ammunition is a delusion and a snare.

* With such a carriage a buffer would probably be necessary as the recoil is very great.

62. Large scale—colored—lithographs should be provided showing sections of the gun, ammunition, &c., and of any parts of the carriages, &c., (such as buffers) that might demand special explanation. There should also be a few pictures showing the effect to the eye of the burst of "good" and "bad" shells. Lithographs

63. The German Instruction Sight (fully described in R. A. I. Papers, Vol. X., No. 2, p. 223,) should also be issued, and a list kept of all the trustworthy marksmen in the battery. Instruction sights.

64. For drill purposes, shells should be issued furnished with a dummy fuze, which should be set to a given range, whenever a round is fired. Dummy fuze.

65. For the purpose of aiming drill, judging distance, and the practice of firing at moving objects, we should suggest the adoption of targets on the following principle :—In Plate IV., Fig. 6, suppose that a gun is placed at *O*, let $OC = 1000$ yds., and let $AB = 600$ yds., and let *AB* be at right angles to *OC*. Let $OE = \frac{1}{20}$ of *OC*, that is, let it = 50 yds. Then an object placed at *C* will present the same appearance to the eye at *O*, as an object $\frac{1}{20}$ the size placed at *E*. That is to say a target of the dimensions 4·8 ins. × 3·6 ins. × 34·2 ins.* placed at *E*, would represent a field battery gun limbered up 1000 yds. away; now we can always get a range of 50 yds. in the barrack square (but if more convenient a scale of $\frac{1}{40}$ could be adopted) and we could thus represent the appearance of a gun or troops 1000 or 2000 yds. away. Moving targets.

66. Again, suppose $AC = CB$ and *DF* parallel to *AB*. Join *OA*, *OB* cutting *DF* in *D* and *F*. Then, if the small target moves from *D* to *F* at the *proper speed* it will represent to the eye at *O* the appearance of the actual gun moving from *A* to *B*. *AB* is 600 yds., and this space would be traversed at the trot in 150 seconds, as a horse may be supposed to trot 240 yds. a minute. The little target should of course traverse *DF* in the same time, but *DF* is only 30 yds., its speed will therefore be 7·2 inches a second.

Therefore, to represent the appearance of a gun or troops moving across our front any distance off, we have only to set up at $\frac{1}{20}$th this distance, a target $\frac{1}{20}$th of the natural size and make it move at a certain speed.

To represent Infantry the target should move as follows :—

3·6 inches a second for the walk, as Infantry walk 120 yards per minute.
5·4 " " double, " double 180 "

For Cavalry and Artillery :—

7·2 inches a second for the trot, as a horse trots 240 yards a minute.
10·8 " " gallop, " gallops 360 "

If the scale of $\frac{1}{20}$ be adopted as the most convenient, targets, made of light frames of wood covered with canvas, painted to represent the actual objects, should be constructed $\frac{1}{20}$th the natural size of cavalry

* Taken as $\frac{1}{20}$ the actual dimensions of a field piece limbered up.

squadrons, infantry companies, guns, detachments, &c. These frames should fit over a little carrier, which would be made to move over a prepared path 20 or 25 yards long, or even shorter.

The path could be made in two ways. (1) It might be made of polished wood upon which the carrier would slide, being drawn by a silken cord. The objection to this is that there would be a certain amount of difficulty in levelling it. (2) The path might consist of *water*. If a V-shaped trough were constructed in three lengths, and the carrier made in the form of a long narrow boat, there would be no trouble in levelling, and the target could always be used with facility, except in the case of a high wind.

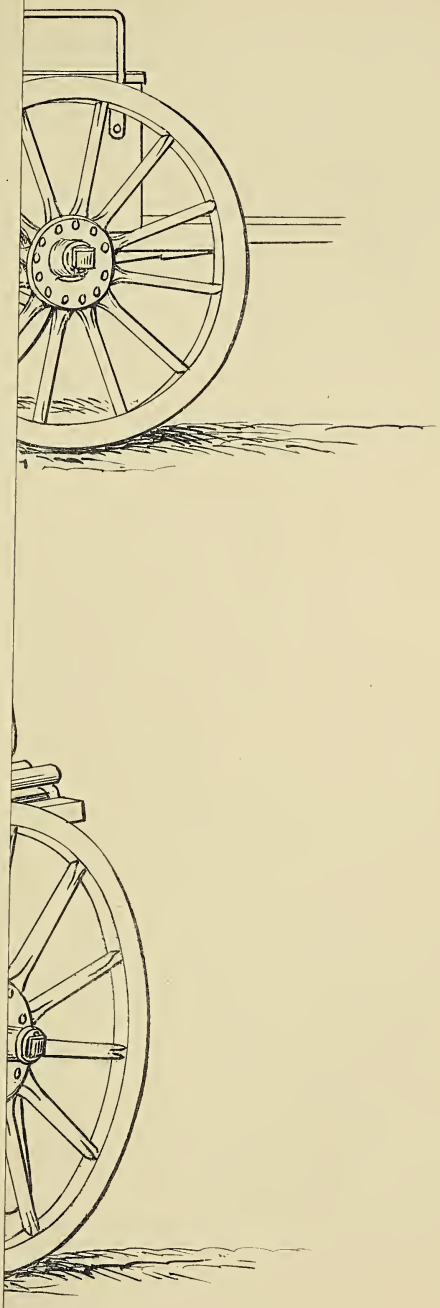
The targets would be drawn by silk cords, which would pass over a system of three or four pulleys, which would be provided at both ends of the path, so that the target could be made to move either from right to left or left to right. It would be a simple calculation to determine the requisite weights to be suspended from the cord, in order to give the various speeds required. A clockwork arrangement would do equally well, but it would be more expensive, liable to go out of order, and not so simple.

By placing the path in different ways, objects moving directly or obliquely across the range could be represented. When the path is set up as required, the mode of procedure would be as follows:—A man stands at each end of the path: the target is drawn to one end, and the weight corresponding to the required speed is suspended from the cord. The gun is brought into action, and, at the same time, the target is released. It begins to move along the path, and when the man laying the gun calls "fire" the target is arrested in its course. This is effected by one of the men at the "path" laying his finger on the silk cord which the carrier will draw after it, and which will serve to pull it back on its return journey. By looking over the gun the instructor can then observe what sort of shot is made.

67. The same principle might be carried out with stationary targets. Representations of batteries, companies, gun-pits, and entrenchments could be drawn on a scale, say, of $\frac{1}{20}$, and set up at $\frac{1}{20}$ the actual range from the guns. The eye would be greatly educated by this, and judging distance learnt.

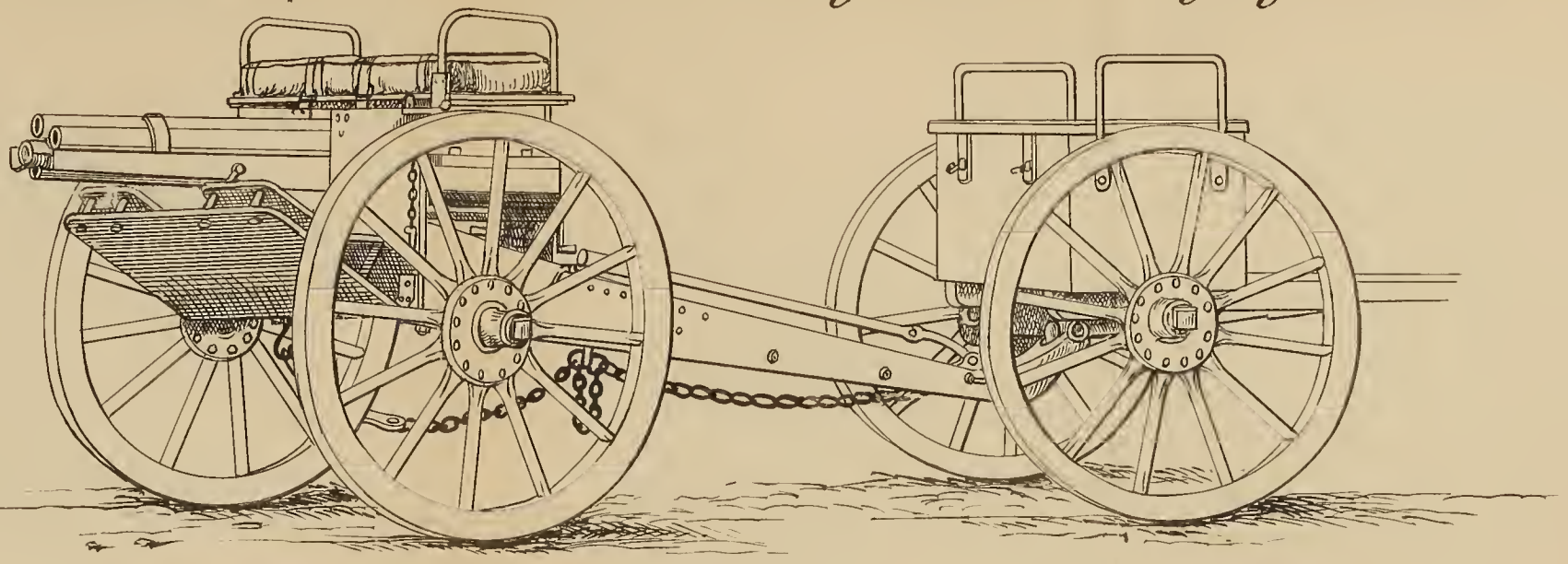
68. What we would claim for the targets above described is that they would give practice in the barrack-square at objects that would be met with on service, a practice that our men seldom or never get; that they would interest them in their work, and give an appearance of reality to the drills; that they would educate the eye to the appearance of various objects at various ranges, and that, by using them with dummy shells, properly fuzed, we should daily carry on a practice in the barrack-square, the fruits of which we should reap on service.

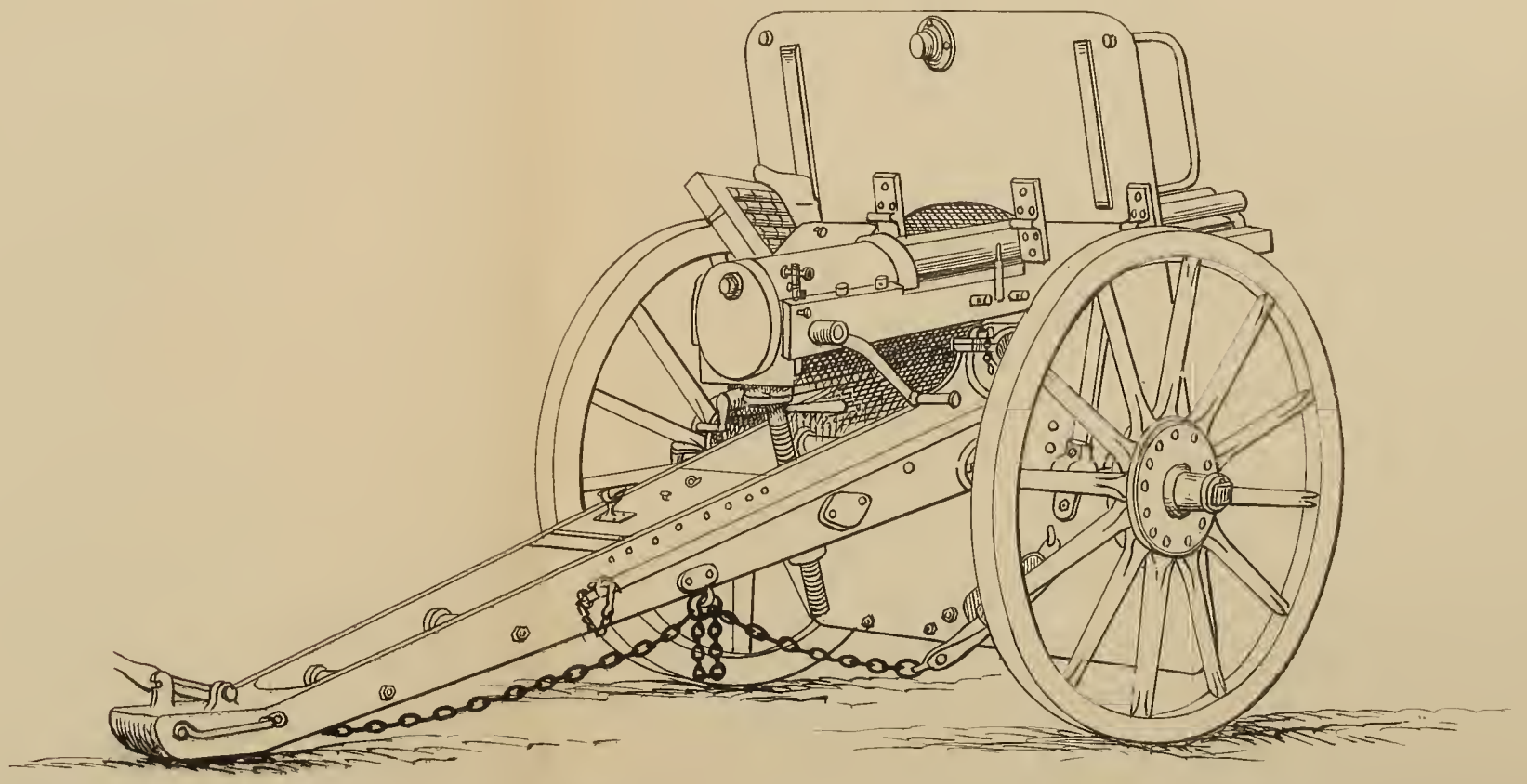
sing a gun Shield.



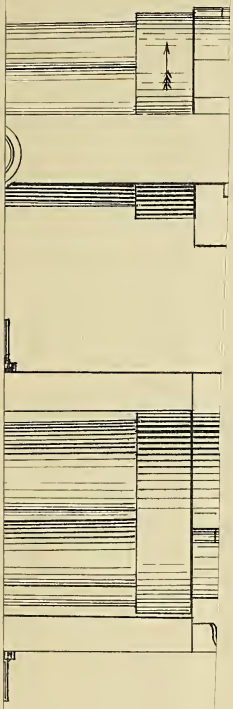
HOTCHKISS REVOLVING CANNON.

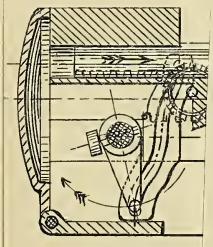
Limbered up and in action./Shewing mode of using a gun Shield.



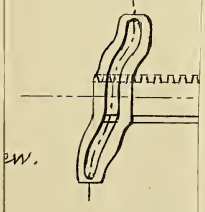


NNON.





LONGITUD



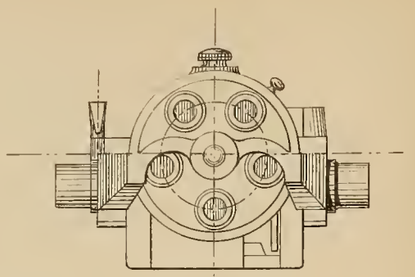
Extr.

Cog-wheel.

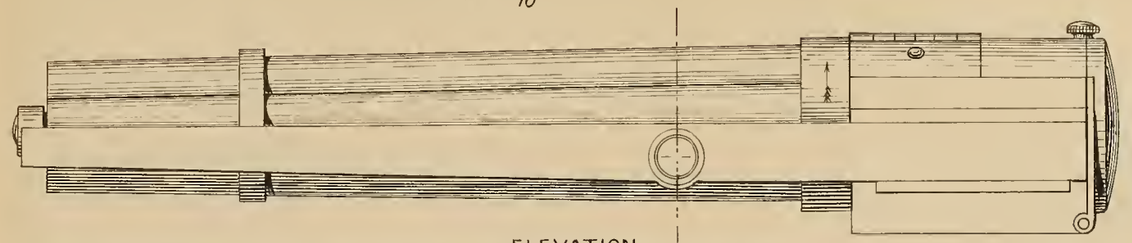
HOTCHKISS REVOLVING CANNON.

PL. II.

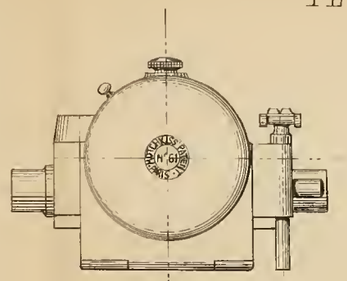
SCALE $\frac{1}{10}$



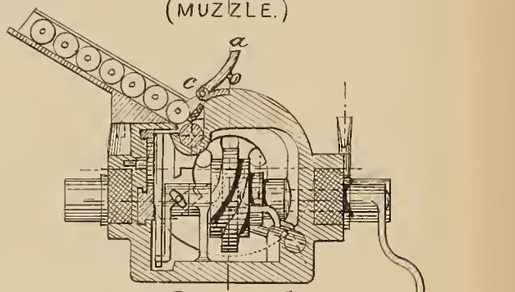
(MUZZLE.)



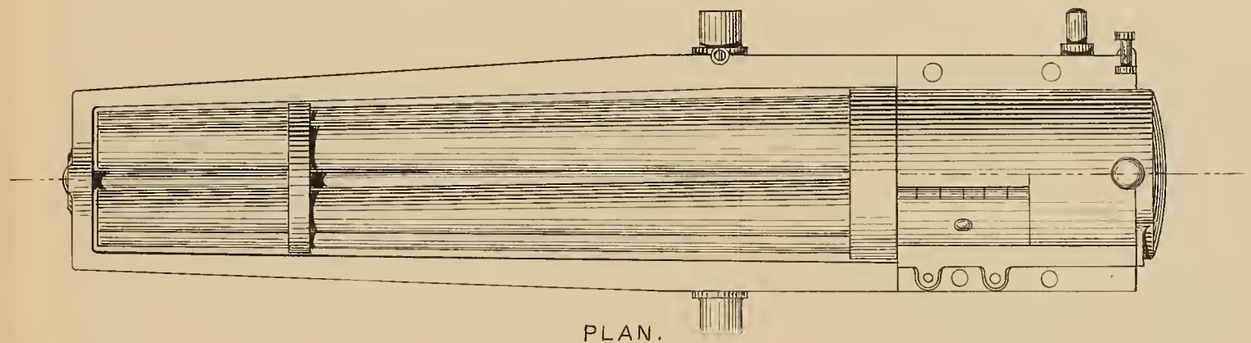
ELEVATION.



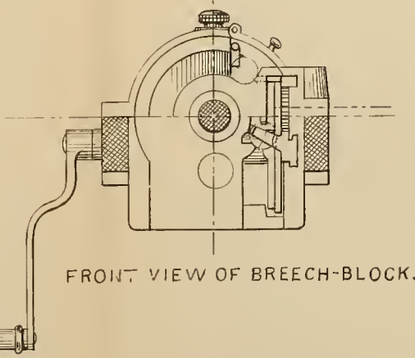
(BREECH.)



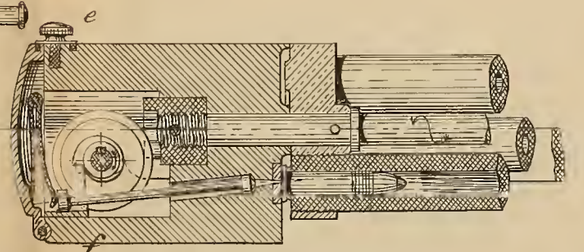
SECTION THROUGH *e.f.*



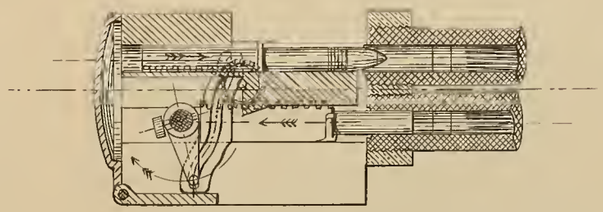
PLAN.



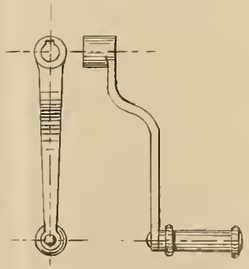
FRONT VIEW OF BREECH-BLOCK.



LONGITUDINAL SECTION THROUGH *a.b.*

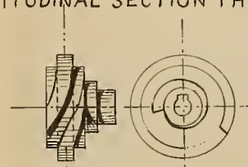


LONGITUDINAL SECTION THROUGH *c.d.*

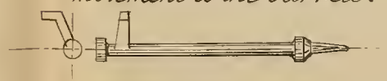


Hand-crank.

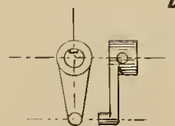
Crank-shaft.



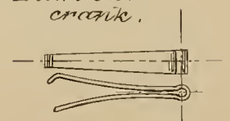
Worm, giving rotating movement to the barrell.



Firing-pin.



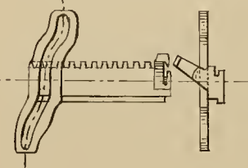
Extractor crank.



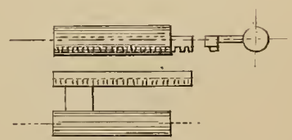
Spring.

DETAILS.

Thumb-screw.

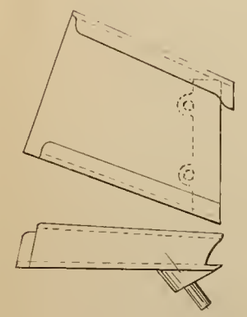


Extractor.



Loading piston.

Cog-wheel.



Feeding trough.

FIG. 5.

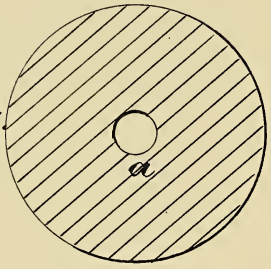


FIG. 6.

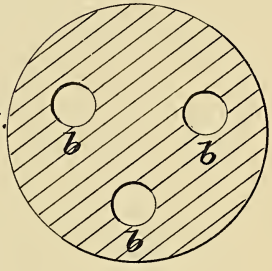
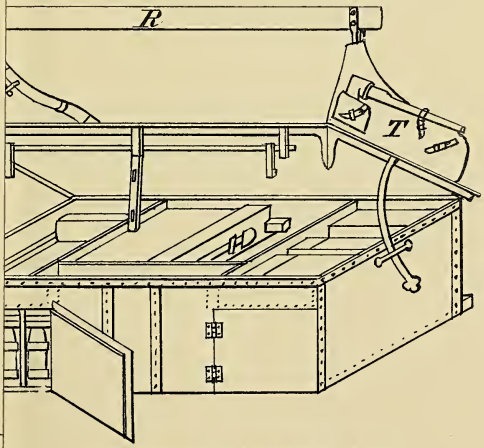


FIG. 4.



GERMAN LIMBER BOX.

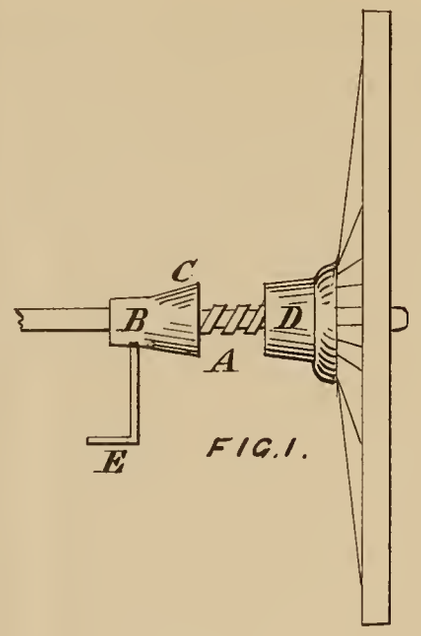


FIG. 1.

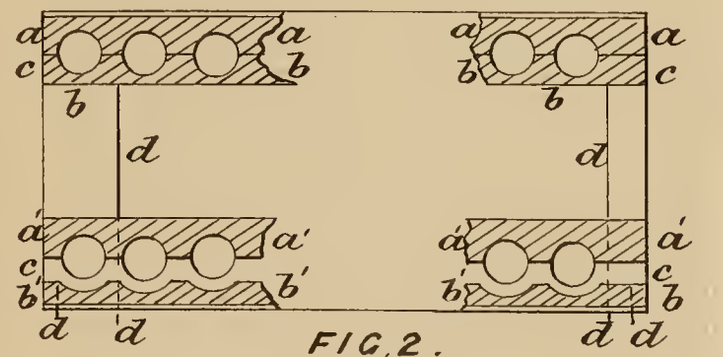


FIG. 2.

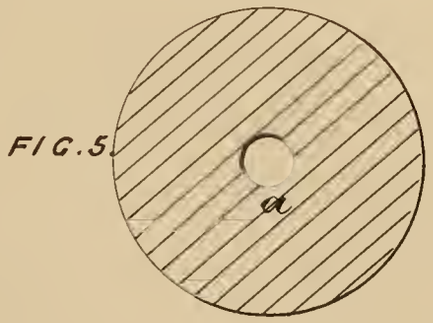


FIG. 5.

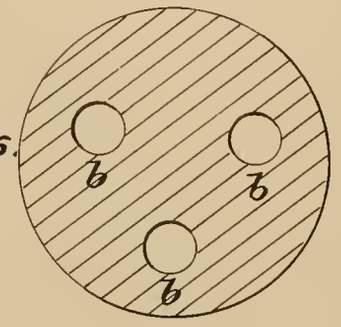


FIG. 6.

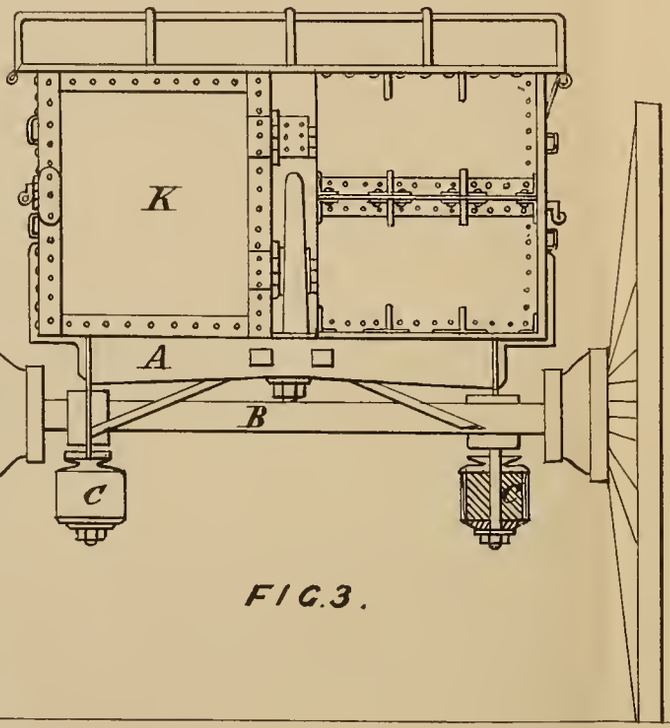
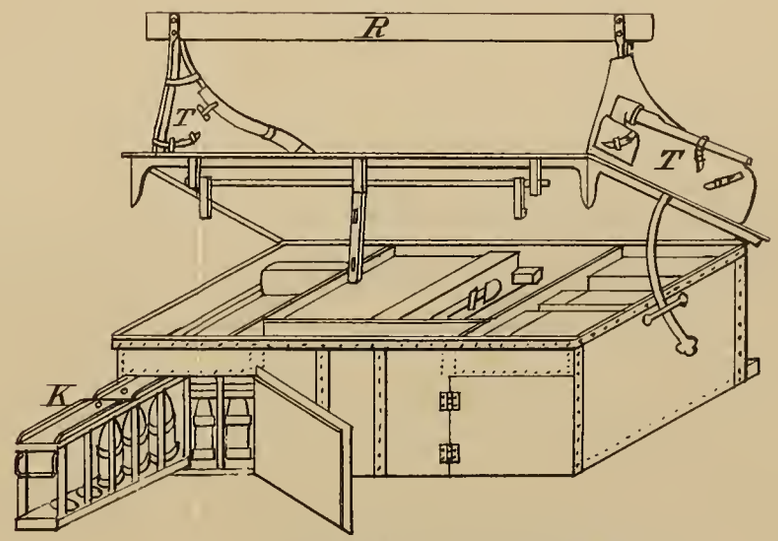


FIG. 3.

FIG. 4.



GERMAN LIMBER BOX.

Italian Shrapnel Case shot.

Austrian Carcass.

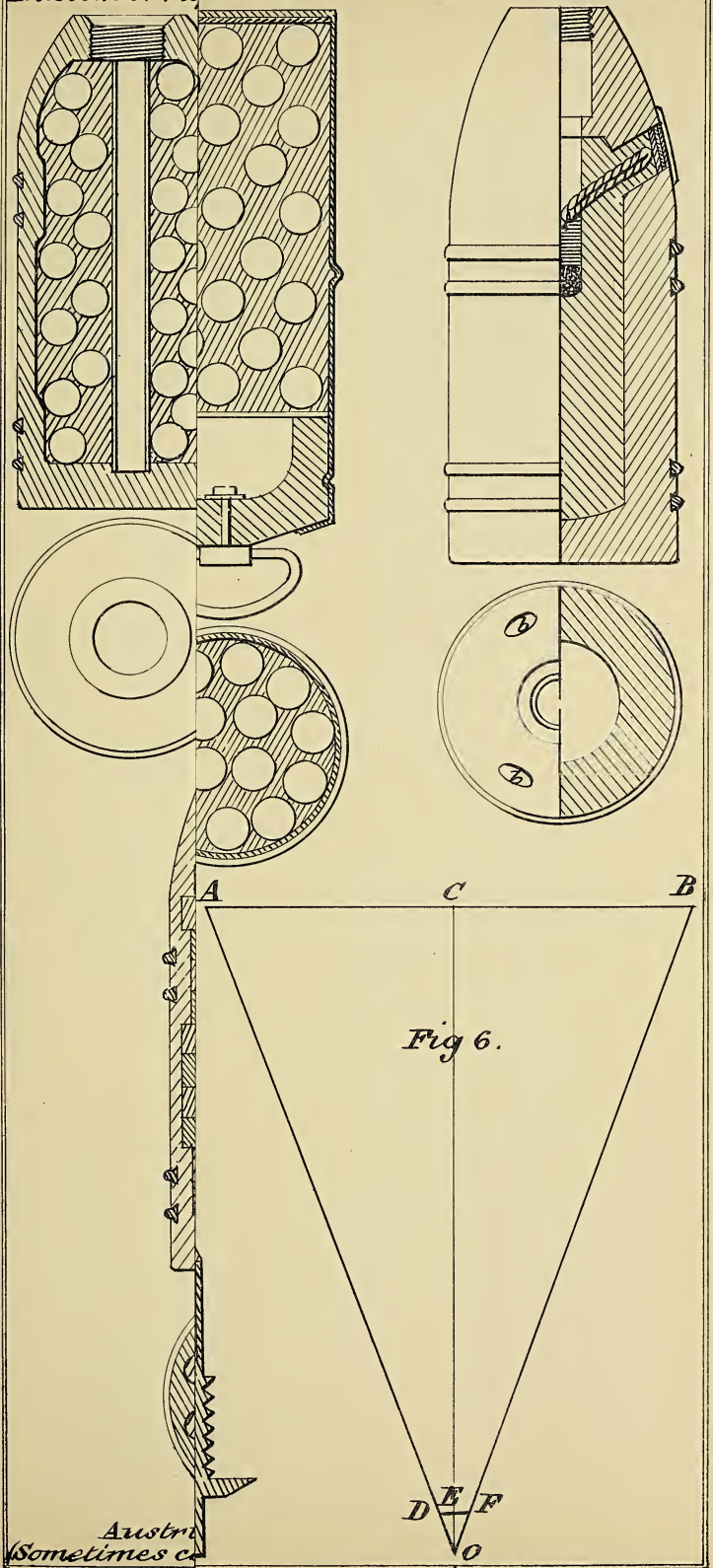
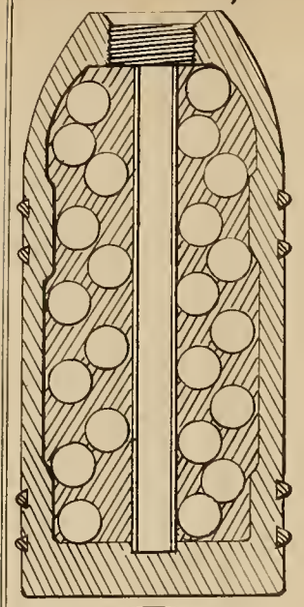


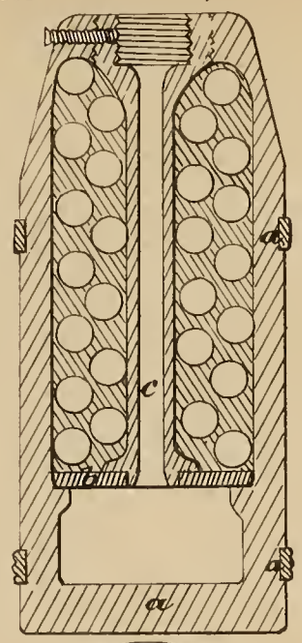
Fig 6.

Austri
Sometimes c

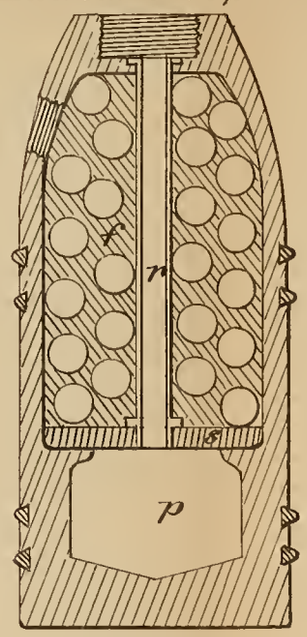
Italian Shrapnel.



Russian Shrapnel.



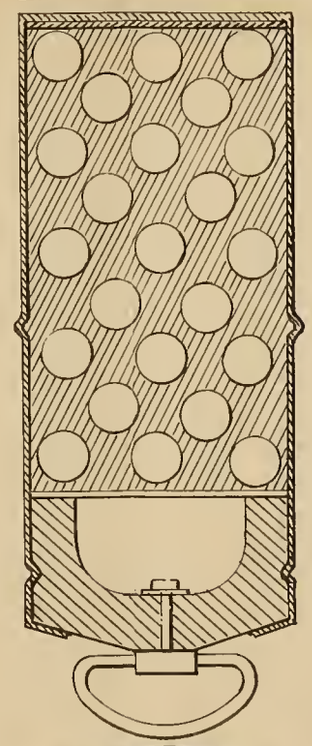
Austrian Shrapnel.



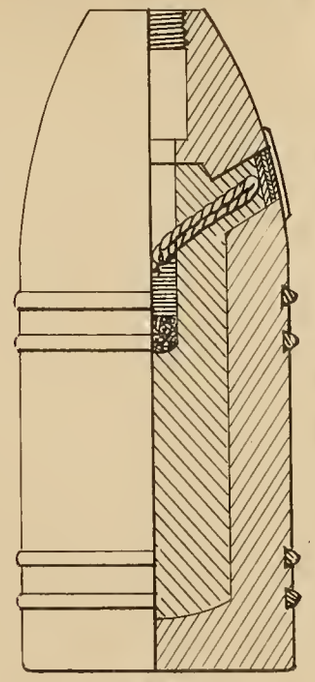
Proposed Shrapnel.

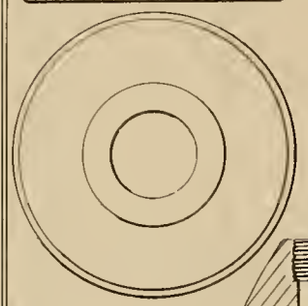
Elevation on A.B.C.
Fig 4.

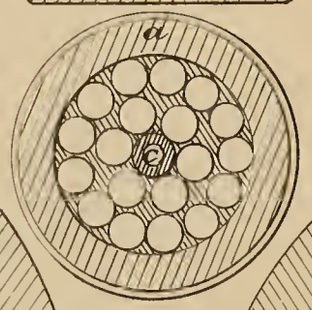
Austrian Case shot.

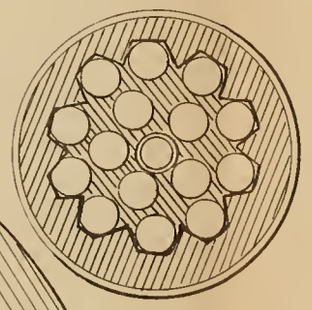


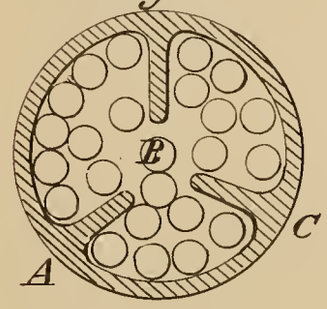
Austrian Carcass.

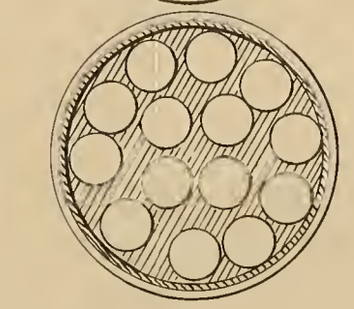


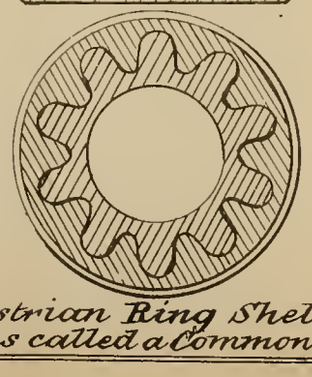












Austrian Ring Shell.
(Sometimes called a Common Shell.)

Fig 5.

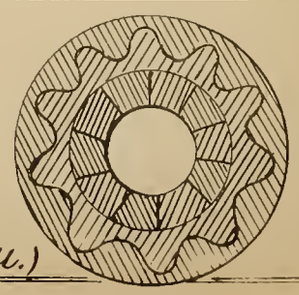


Fig. 1.

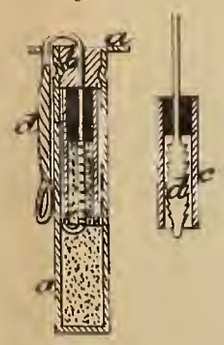


Fig. 2.

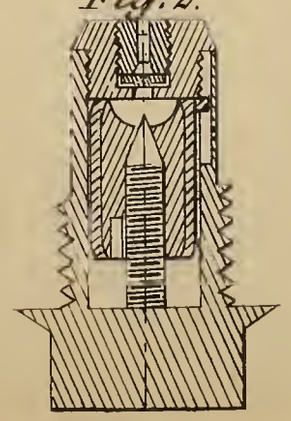
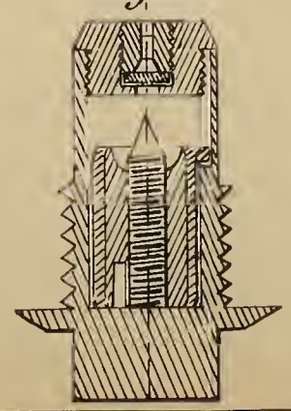


Fig. 3



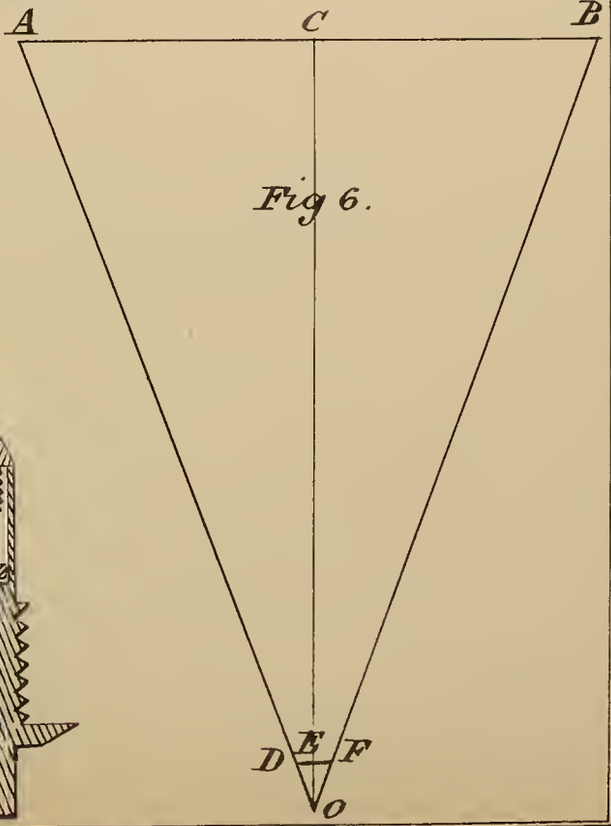
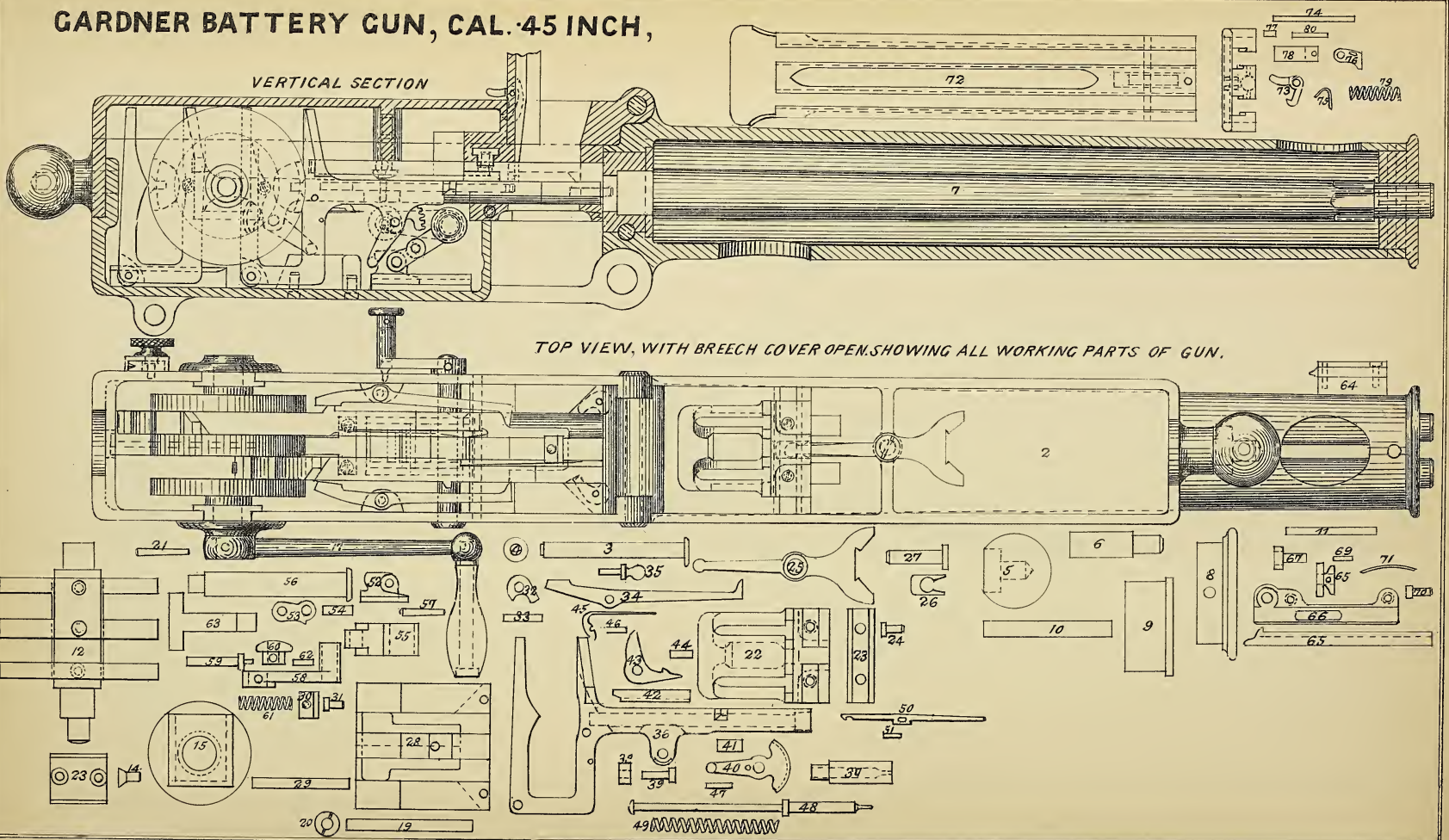


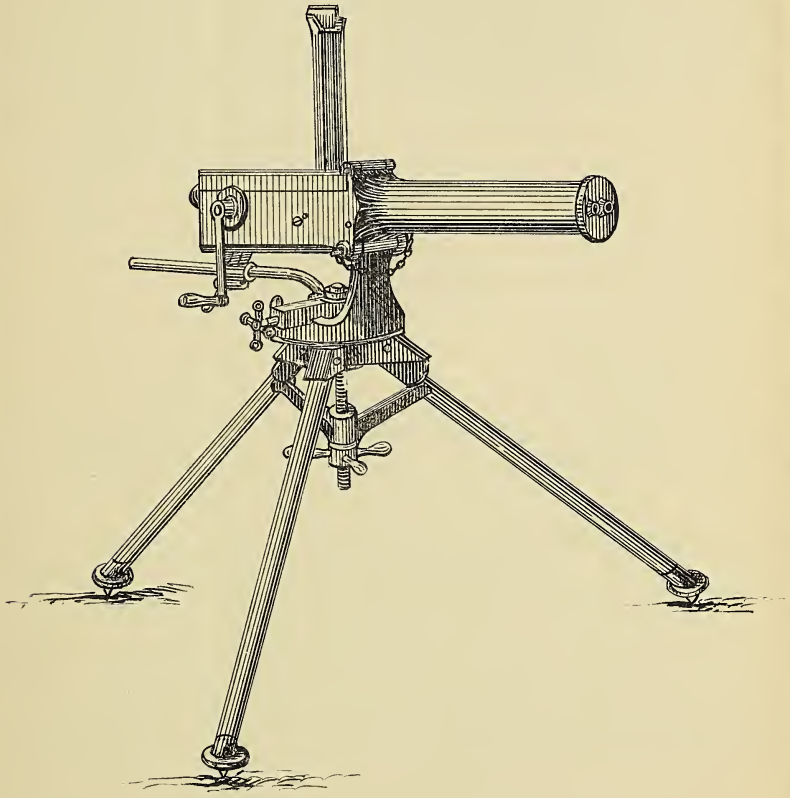
Fig 6.

PL.V.

GARDNER BATTERY GUN, CAL. .45 INCH,



GARDNER GUN MOUNTED ON TRIPOD.



NOTES.

A. A screw is cut on each axletree-arm at (A), this screw carries a nut (B), forming a conical cap (C) capable of fitting over the inner part of the nave (D), which is likewise conical, to fit inside the cap. The nut has a crank (E) by which it can be revolved on the axletree. When the nut is tightly screwed up the wheel is fixed; the screws on the axletree-arms have right and left-handed threads, so that the caps become tightened by the act of recoil, and can at once be loosened by running the gun forward. The advantage of this brake is that it can be set so that its action will commence after the gun has recoiled a foot or any given number of feet, the strain on the carriage being thus reduced to a minimum. Once set, the brakes require no attention, and will act for any number of rounds. They also can be used instead of the drag-shoe,* and can be applied and withdrawn when the carriage is proceeding at speed. It is easy to imagine circumstances where this facility would be of importance, especially in rapid movements under fire. *See pl. III., fig. 1.*

B. Thus we read in the account of the battles round Metz, (by Hoffbauer) "The deficiency of the ammunition had its influence in checking the detaching of the batteries in this way,—the slowness of the fire and the silence of some of the batteries encouraged the enemy to make more frequent and vigorous attacks. The 5th Division was prevented from taking part in the last attack on the enemy by the want of ammunition." Nor can we hold the Artillery at large responsible for this by their want of mobility, for in the same work we read "in spite of the great distance it had to march, the divisional artillery came up to assist in the attack made by the Cavalry," and again, "we see the batteries of the 1st Army Corps in action a considerable time before the 1st and 4th Brigades came into line."

C. We find the following results recorded in the tables of "Practice under Service Conditions" in Dr. Beckcrheim's "Field Artillery."

Country.	Range. yds.	Target.	Hits per round.
Austria ...	2000–2500	... Company in line. ...	20 Time shell. 18 Percussion shell.
,, ...	,,	Company forming line from column.	38·5 Time shell. 18·3 Percussion shell.
Germany ...	2406	... Infantry column ...	18 Time shell. 8 Percussion shell.
,, ...	875	... ,, ,, ...	220 Time shell. 17 Percussion shell.
Russia ...	2216	... ,, ,, ...	151 Time shell. 22 Percussion shell.

N.B.—The Time shell means a *shrapnel with time fuze*, the Percussion shell, a *ring or double-wall shell* and *percussion fuze*. This, however, is but the result against targets more or less in the open, and the fact is recognised that on the field of battle cover will always exist, more or less, and that no matter how good a shell may be in the open, it is advisable to provide for other contingencies.

D. This fuze is shown in Plate IV., Figs 2 and 3, and it is claimed for it that it is "absolutely effective, completely safe *during the transport of the projectiles*, to which the fuzes can be attached. No manipulation is required to arm the fuze before the discharge of the projectile." The fuze consists of two main parts, the *case* and the *plunger*. The plunger is composed of three parts, (1) the lead body, (2) a brass case which envelopes this body, and (3) a central pin which is roughened in such a way that the surrounding lead has sufficient hold on it to prevent displacement except by great force. The detonating patch is carried in the case. Fig. 2 shows the fuze before the gun is fired, and it is evident that the pin and detonating composition cannot come into contact on account of the hard brass case (2) that forms part of the plunger. But after the shock of discharge the fuze assumes the appearance shown in Fig. 3; that is to say, the heavy pellet of lead sets back on the firing pin, but after the shock is passed the lead again closes round and grips it firmly; on impact, pellet and pin move again forward, the latter comes in contact with the detonating composition and fires the fuze.

E. There are two patterns for field purposes of the following weights:—

	Heavy.	Light.
Weight of gun	950 lbs.	450 lbs.
,, projectile	1 lb. 4 oz.	1·05 lb.
,, bursting-charge	8·4 oz.	·8 oz.
,, powder charge...	3·6 oz.	2·9 oz.
Initial velocity	1500 f.s.	1330 f.s.
Total weight behind splinter-bar including four (10 st.) gunners and 300 rounds	4660 lbs.	3360 lbs.

The ammunition consists of a metal cartridge, including powder-charge, shell, and percussion fuze,

*The drag-shoes are reported to have been constantly broken in S. Africa. It is not meant that the gun-brake should supersede them for ordinary purposes on the march, but it is available in case of emergency.

and a sufficiency of this is carried in the above equipment. A single pack animal could carry over 100 rounds. These weights, 3360 lbs. and 4660 lbs., are well under the limits laid down for horse and field batteries, but we confess we would prefer to see a more powerful gun than the above, which would utilize the total allowable weight; for if a gun of this sort is to be associated with the field gun in the same battery there can be no advantage in its being lighter than its companion. Six horses could draw either of the above guns, and it seems but a poor excuse for advocating a less powerful weapon to say it may be drawn by two or four horses, when we remember it is *field* and not *mountain* equipment that is under discussion.

F. The following are the weights:—

Gun	112 lbs.
Carriage	120 lbs.
Weight of complete cartridge	2½ lbs.
" powder charge	100 grs.
" bursting-charge	22 grs.
" shell	2 lbs.
Range of gun	7000 yds.

* *Extract of Report of Officer in charge of these guns in operation against the Indians last year.*

To A. A. G., Department of the Missouri, Kansas.

Sir,—* * * * * * * * The mountain gun is simply invaluable; it knocks the stone fortifications down readily. The accuracy of the fire is something wonderful.

(Signed) E. Hatch,
Colonel, 9th Cavalry.

Note on Personal Equipment.

It would be found at once economical and expedient to recognise the fact that a soldier should have two dresses which should be quite distinct, as the functions they have to fulfil are totally different. There should be one dress for display, for reviews, gala occasions, and such like, and another for barracks, battery drill, and service. We propose dealing with the latter.

The coat should be a loose Norfolk jacket of the strongest cloth, without the plaits, lined with flannel, and provided inside and out with pockets. The mounted men should have pantaloons, as at present, but they should be better made and cut more in the shape of hunting breeches. The boots, of the present shape, should be cut over the instep, the slit being closed by a tongue and lace, and the aperture should be hidden by a broad spur-strap. The dismounted gunners should have "breeches and gaiters," the latter of black leather, and shooting boots.

The headdress should be the helmet, though it is possible to obtain a better pattern than our present one. The forage cap should be similar to that worn by the French Imperial Guard (1870), and which has been at times copied by officers of the English guards at manœuvres, &c. It can be folded flat, does not go out of shape, looks smart, and feels comfortable.

A brown leather belt should be worn round the waist, which should carry the revolver in its case, and a small ammunition pouch to hold, say, 24 rounds; the inside of this pouch should be fitted in such a way that each cartridge should be separate, so as to be easily extricated by the fingers. It is now generally admitted that it is necessary that the gunners and drivers should carry some defensive weapon, and no doubt revolvers will be issued to them in the next campaign; at present they are at a great disadvantage, as an instance of which it may be noted that an English officer in the Balaclava light cavalry charge placed with his own hand a whole Russian gun detachment *hors de combat.*

The sword is a useless encumbrance on foot; on service this weapon should be attached to the saddles of the men who carry it, and special scabbards, covered with leather and lined with wood, should be provided.

The water-bottle and haversack (the latter made of waterproof canvas) should be slung over the shoulder by leather straps.

By a lanyard round the neck should be carried a strong clasp knife, provided with hoof picker and leather-borer, and fitted with a small pair of tweezers.

The officers should have exactly the same dress as the men, they and the N.-C. officers being distinguished by small badges, invisible 100 yards off. Officers should, in addition to the above, carry a pair of field glasses in a leather case, provided with loops; when not in use, this case should be worn on the waist-belt in the centre of the back; when the field-glasses were required, the case could be pulled round to the side. This would be more convenient than having (as is usual) the case attached to the saddle.

The battery officers should also carry spring-spikes.

Besides the articles enumerated in Army Circulars, 1st Dec., 1877, the kits should include a fisherman's wool cap and a bandage, and inside the coat should be sewn (as in the German army) a parchment ticket containing the man's name and number, and space for the remarks of the surgeon under whose hands he would first come in case he were wounded. Much suffering is saved by this plan, as, of course, a wounded man is liable to be moved from one surgeon's care to another's. A small metal soap-box would also be useful.

The present cloak appears of a good practical kind, but the short cape should be abolished, and an extra thickness of cloth given to the coat over the shoulders.

ABSTRACT OF THE PROCEEDINGS

OF THE

FORTY-FOURTH ANNUAL GENERAL MEETING

OF THE

ROYAL ARTILLERY INSTITUTION.

The 44th Annual General Meeting was held in the Theatre of the Institution on Thursday, 23rd June, 1881, Maj.-Gen. Hon. E. T. Gage, C.B., Comdg. the Woolwich District, in the Chair.

I. The Notice convening the Meeting was taken as read.

II. The Abstract of the last Annual General Meeting was taken as read.

III. The Forty-fourth Annual Report, which was as follows, was read:—

1. The Committee beg to submit the 44th Annual Report of the Royal Artillery Institution.

2. There are now 1558 Members of the Institution (*vide* Appendix, Table C). During the past year 69 officers joined, whilst the deaths and withdrawals amounted to 76, showing a decrease of 7 in the year. The number of deaths which occurred in the year was even larger than last year. Amongst them are to be noted those of General Sir John Bloomfield, G.C.B., the last of the Waterloo Officers, and Captain W. Boylin, a retired Riding-Master, who, as the drummer boy of the Main Guard, beat a roll on the drum on receipt of the news of the victory in this Garrison; Lieut.-General Rowan, C.B.; Lieut.-General Franklin, C.B.; and Major-General H. A. B. Campbell, C.B. Majors Blackwood and Poole, Captain Greer, and Lieut. E. G. Osborn were killed in action.

3. The accounts have been audited this year by Major Wethered, Staff Paymaster, and Capt. L. F. Perry, R. A. It will be seen that the financial condition of the Institution is very satisfactory (*vide* Tables A, B, and D); the general credit amounting to £3014 10s. 10d. The funded property has been increased by £300.

4. The French and German Classes held in the Institution have been fairly well attended. The Landscape Drawing Class has retained its popularity. Classes and individual officers have been assisted by Institution funds at several out-stations for the study of French, Spanish, Italian, Russian, Turkish, Landscape Drawing, and Mapping.

5. The Committee have continued the supply of foreign military periodicals to Members willing to furnish from time to time, for publication with the "Proceedings," reviews and précis of their contents, as well as translations in full of important articles.

The applications for the magazines under these conditions have been numerous, and the Committee believe that the publication of much valuable professional information hitherto comparatively inaccessible, has been the result of this experiment.

6. The subject selected for the Prize Essay of the year was "The Equipment of Field Artillery."

Eight Essays were submitted for competition.

Colonel Reilly, C.B., Colonel Goodenough, and Colonel Stirling, C.B., A.-Q.-M.-G., were good enough to undertake the office of Referees.

The two following Reports were received from the Referees :—

(1).

WOOLWICH,
25th May, 1881.

DEAR SIR,

We, the undersigned, are of opinion that Essay No. 6 is the best of the eight submitted to us, and is fully entitled to the award of the Gold Medal by the R. A. Institution.

We have not selected any Essay as second in order of merit, and we do not recommend any award of a Silver Medal this year.

We are of opinion that there is matter in the other Essays which would be of interest to the Regiment at large, and which might be extracted and published in some form if it is considered proper to do so.

We understand from a private communication received from Colonel Reilly that he wholly disagrees with us in our award, hence we address you separately.

We have the honor to be,
Sir,
Your obedient Servants,
W. H. GOODENOUGH, Lieut.-Col. & Col.
W. STIRLING, Col., A.-Q.-M.-G.

The Secretary,
R.A. Institution.

(2).

ALDERSHOT,
26th May, 1881.

SIR,

Two of the judges having agreed as to which Essay on Field Equipment is entitled to the Gold Medal, when announcing the name of the successful competitor I beg that you will notify that I dissent from the award.

I have the honor to be,
Sir,
Your obedient Servant,
E. REILLY, Colonel.

The Secretary,
R.A. Institution.

Under the circumstances the Committee have decided to adjudge the Gold Medal to the author of Essay No. 6.

7. In accordance with the resolution of a previous General Meeting, the papers connected with the history of the Regiment presented to the Institution by the late Lt.-Col. Cleeveland, R.A., are in the hands of the printers, and the Committee trust that they will be published in the course of the current year.

8. In mentioning the appointment, under Rule VII., of Capt. L. F. Perry, as Assist. Secretary, R. A. I., the Committee beg to convey to that officer their best thanks for accepting an office which brings with it neither pecuniary compensation nor diminution of military duty.

9. No presentations of Birds or Insects were made to the Natural History Museum during the year.

10. The following Lectures were delivered during the year :—

The Spectroscope	Professor Silvanus P. Thompson, D.Sc., B.A., F.R.A.S.
Waves of Sound and the Photophone	
Food and Digestion	Dr. Richardson, F.R.S.

11. The following changes in the Committee took place during the year :—

Colonel R. Oldfield	vice	Major E. J. Ward-Ashton.
Captain F. Roberts	"	Captain G. Mackinlay.
Lieut. J. R. J. Jocelyn ...	"	Lieut. P. C. E. Newbigging.
Lieut.-Col. Hon. A. Stewart	"	Colonel F. T. Whinyates.
Major H. S. Clarke.....	"	Major F. Duncan.
Captain C. W. Long	"	Lieut F. W. Radcliff.
Lieut.-Col. C. E. Nairne...	"	Lieut.-Col. W. L. Yonge.
Captain R. S. Watson.....	"	Captain C. Jones.
" J. M. Alves	"	" K. Stephenson.
Lieut. J. S. S. Barker	"	Lieut. J. R. J. Jocelyn.
" R. C. Foster	"	" J. S. S. Barker.

Secretary and Treasurer.

Major H. W. L. Hime ... vice Lieut.-Col. M. Le Fer Taylor.

The Committee at present is constituted as follows :—

PATRON AND PRESIDENT :

Field-Marshal H. R. H. the DUKE OF CAMBRIDGE, K.G.

VICE-PRESIDENTS :

The Inspector-General of Artillery.
The Director of Artillery and Stores.
The Deputy-Adjutant-General, R.A.
The General Officer Commanding Woolwich District.

MEMBERS :

The Assistant-Adjutant-General, R.A.
The Director of Artillery Studies.
The Assistant-Adjutant-General, Woolwich.
The Secretary, Department of Director of Artillery and Stores.
Lieut.-General W. J. Smythe, F.R.S.
" Sir J. H. Lefroy, C.B., K.C.M.G., F.R.S.

Colonel H. T. FitzHugh.	Major W. Brancker.
" R. Oldfield.	" H. S. Clarke.
" W. N. Waller.	Captain C. W. Long.
Lieut.-Col. E. Maitland.	" F. Roberts.
" C. E. Nairne.	" S. C. Pratt.
" Hon. A. Stewart.	" R. S. Watson.
" J. E. Blackwell.	" J. M. Alves.

Lieut. R. C. Foster.

Major H. W. L. Hime, *Secretary and Treasurer.*

Captain L. F. Perry, *Assistant Secretary.*

TRUSTEES :

General Sir G. St. George, K.C.B.
" " E. C. Warde, K.C.B.
D.-A.-G., R.A., for the time being.

IV. The Annual Report having been read to the Meeting, it was proposed and carried :—

"That the Annual Report, as read, be adopted."

V. The Secretary was requested to open the sealed envelope containing the name of author of Essay No. 6, to whom the gold medal had been adjudged. On doing so, Capt. J. R. J. Jocelyn was found to be the successful competitor.

VI. It was proposed and carried that Clause 2 of the Memo. relating to the Annual Gold Medals, dated 8th Sept., 1870, be cancelled. The clause was as follows :—

"The Essays shall be, in alternate years, on matters connected with (*a*) the duties and position of artillery, and (*b*) the manufacturing departments."

VII. It was proposed and carried that the following be the subject for the Prize Essay of 1882 :—

"The Training of Garrison Artillery for the Attack and Defence of Fortresses."

Printing { Wa… Pap… Typ… Woo… Lith…
Photography …
Classes …
Lectures …
Taxidermy …
Library, and Bo…
Museum …
Instruments…
Carpentry { Wa… Mat…
Furniture and R…
Subscriptions to …
Stationery …
Postage and Par…
Incidental Exper…
Wages to Clerks …
W.O. Photograp…
Gold Prize Med…
Fire Insurance …
Refund of Subsc…
Power of Attorn…
Purchase of £30…

Cash in hand, 31…

Dr.

Printing, Woodc…
Classes …
Museum …
Books and Perio…
Laboratory Apps…
Carpentry and P…
Stationery …
Postage and Par…

E…
E. R. WETH…
LIONEL F. …
Woo…

APPENDIX.

A.

GENERAL ABSTRACT

OF THE

INCOME AND EXPENDITURE OF THE ROYAL ARTILLERY INSTITUTION,

From 1st April, 1880, to 31st March, 1881.

EXPENDITURE.

		£	s.	d.	£	s.	d.
Printing	Wages	126	17	0			
	Paper and Materials	325	11	1			
	Type and Furniture	5	18	2	549	13	0
	Wood Engraving	15	2	0			
	Lithography	76	4	9			
Photography					2	3	0
Classes					211	8	0
Lectures					43	9	0
Taxidermy					0	8	6
Library, and Books for Sale					400	15	11
Museum					26	18	0
Instruments					44	6	6
Carpentry	Wages	20	17	4	115	3	4½
	Materials	94	6	0½			
Furniture and Repairs					26	6	1
Subscriptions to Societies					3	3	0
Stationery					113	11	10
Postage and Parcels					90	10	8½
Incidental Expenses					50	3	2
Wages to Clerks and Orderlies					146	14	7
W.O. Photographs and Lithographs					4	2	5
Gold Prize Medal					11	1	6
Fire Insurance					15	7	0
Refund of Subscriptions					5	10	0
Power of Attorney, Transfer of Stock					0	16	6
Purchase of £300 Consols					296	5	0
Cash in hand, 31st March, 1881	Of Secretary	3	2	11	395	12	7
	„ Messrs. Cox & Co...	384	6	11			
	„ Army&NavyCo-op.Soc.	8	2	9			
					£2553	9	8

INCOME.

		£	s.	d.	£	s.	d.
Cash in hand, 31st March, 1880					632	0	0½
Printing					54	4	0
Photography					0	3	0
Classes					53	2	6
Books and Binding					239	8	0
Taxidermy					0	8	6
Instruments					0	6	0
Carpentry					41	17	3
Subscriptions	Entrance	62	0	0	1337	16	0
	1875-6	2	11	6			
	1876-7	3	17	6			
	1877-8	5	18	0			
	1878-9	13	4	0			
	1879-80	35	11	0			
	1880-1	1203	12	6			
	1881-2	11	1	6			
Stationery sold					93	16	2
Postage and Parcels					39	9	6½
W.O. Photographs and Lithographs					2	8	8
Dividends on Consols					58	10	0
					£2553	9	8

B.

DR. DEBTOR AND CREDITOR ACCOUNT ON THE 31st MARCH, 1881. CR.

	£	s.	d.	£	s.	d.
Printing, Woodcuts, and Lithography	29	1	10			
Classes	6	6	0			
Museum	7	10	0			
Books and Periodicals	96	9	4			
Laboratory Apparatus	3	11	0			
Carpentry and Picture Framing	4	15	11			
Stationery	11	17	10			
Postage and Parcels	2	14	10			
General Credit 31st March, 1881	3014	10	10			
Cash in hand, 31st March, 1881				395	12	7
£2300 Consols Stock, at 98½				2284	13	4
Value of Stock: Printing Paper	50	16	0	119	9	4
Value of Stock: Books for Sale	31	5	10			
Value of Stock: Stationery for Sale	17	7	6			
Value of Stock: Chemicals in Laboratory	20	0	0			
Owing by Members: Printing	7	5	3	377	2	4
Owing by Members: Classes	4	7	6			
Owing by Members: Taxidermy	10	5	0			
Owing by Members: Books and Binding	87	0	10			
Owing by Members: Carpentry	4	5	8			
Owing by Members: Subscriptions	174	11	0			
Owing by Members: Stationery	60	2	9			
Owing by Members: Postage and Parcels	23	1	4			
Owing by Members: W.O. Photos. & Lithos.	6	3	0			
	£3176	17	7	£3176	17	7

Examined and found correct,

E. R. WETHERED, Major and Staff Paymr.

LIONEL F. PERRY, Capt. R.A.

WOOLWICH, 17th May, 1881.

VIII. It was proposed and carried that the words "or as soon after as practicable" be added after the word "May," in Rule XII. of the Institution. The Rule will consequently read as follows :—

"XII. A general meeting of the members to be held during the month of May, or as soon after as practicable, in each year, to receive the annual report of the Committee, pass the accounts, elect the Committee for the ensuing year, and decide on such matters as may be brought before them."

(Signed) E. T. GAGE,
Major-General,
Chairman.

23rd June, 1881.

APPENDIX.

C.

Statement showing Increase and Decrease of Members of the R.A. Institution during the year ending 31st March, 1881.

Ranks.	31st March, 1880.	Increase.			Total increase.	Decrease.				Total decrease.	31st March, 1881.
		Promotions.	Retirement.	New members.		Promotions.	Retirement.	Withdrawal.	Death.		
EFFECTIVE LIST.											
Generals and Regimental Field Officers	523	29	—	1	30	—	24	1	14	39	514
Captains	367	45	—	—	45	29	4	3	8	44	368
Lieutenants	462	—	—	61	61	45	—	7	11	63	460
Paymasters	6	—	—	—	—	—	—	2	—	2	4
Quarter-Masters	5	—	—	—	—	—	1	—	—	1	4
Riding-Masters	3	—	—	—	—	—	2	—	—	2	1
Surgeons-Major	1	—	—	—	—	—	—	—	—	—	1
Veterinary Surgeons	3	—	—	—	—	—	—	—	—	—	3
RETIRED LIST.											
Generals and Regimental Field Officers	93	—	11	—	11	—	—	3	4	7	97
Captains	43	—	2	—	2	—	—	1	2	3	42
Lieutenants	11	—	—	—	—	—	—	—	—	—	11
Medical Officers	4	—	—	—	—	—	—	—	—	—	4
Chaplains	1	—	—	—	—	—	—	—	—	—	1
HONORARY MEMBERS.	43	—	—	7	7	—	—	2	—	2	48
Totals	1565	74	13	69	156	74	31	19	39	163	1558

APPENDIX.

D.

Tabular Analysis of the state of the Royal Artillery Institution from 1851 to 1881.

Year.	Income.	Amount of Stock.	Number of Members	Per centage of Members on Active List to total strength of Regiment.	Remarks.
	£	£			
1851-2	173	500	—	—	
1852-3	214	500	—	—	
1853-4	918*	500	—	—	* About £700 of this year's income was subscribed for furnishing new building.
1854-5	510	500	—	—	
1855-6	580	500	714	96	
1856-7	665	500	746	82	
1857-8	588	1200	?	—	
1858-9	640	1200	794	83	
1859-60	690	1200	863	80	
1860-1	740	700	986	82	
1861-2	800	700	1037	84	
1862-3	936	1200	1108	55†	† Effect of the amalgamation of the Indian Artilleries.
1863-4	977	1200	1167	59	
1864-5	987	1200	1213	58	
1865-6	1030	1200	1265	60	
1866-7	1075	1200	1315	63	
1867-8	1097	1200	1336	65	
1868-9	1115	1200	1377	66	
1869-70	1122	1361	1366	66	
1870-1	1156	1686	1385	67	
1871-2	1174	1686	1377	65	
1872-3	1190	1686	1386	68	
1873-4	1247	1686	1441	76‡	‡ Effect of the removal of the Medical Officers.
1874-5	1313	2000	1485	78	
1875-6	1320	2000	1498	78	
1876-7	1328	2000	1530	80	
1877-8	1338	2000	1553	82	
1878-9	1367	2000	1555	82	
1879-80	1389	2000	1565	82	
1880-1	1396	2300	1558	80	

E.

Presentations to the Library.

Anglo-Afghan War, 1879–80. Sections 1, 2, 3
Franco-German War. Section 13, 14.....
Instructions for the Service of Siege Artillery ...
Sketch of country embracing the Routes to Kandahar and Girishk, from Ghazni and Jacobabad .....
Map of the Turco-Greek Frontier.....
Sketch of country on the Argandab River, embracing the probable position taken up by Ayoob Khan, August and September, 1880 ..
Plan of country around Kandahar.....
Lithographs, R.C.D. Nos. 33, 53, and 54a, R.L. 126, 127, and 128 .....
Progress Report of the Committee on Explosive Substances .....

} Secretary of State for War.

Map of Basutoland and adjacent territory	Secretary of State for War.
Map of the Transvaal, with small Sketch showing lines of communication.....	
Armed Strength of Balkan Peninsula	
Précis of information concerning Basutoland ...	
Armed Strength of Switzerland.....	
Report of the Special Committee on working Heavy Guns, on the trials with the 80-ton Gun	Director of Artillery.
Description of 12·5-in. R.M.L. 38-ton Gun Carriage and Platform	
Germany: Directions for the Equipment of a Column of the Field Ammunition Park and of a Chief Ammunition Depôt. Translated by Capt. W. M'Clintock, R.A.	
Report of Special Committee on Working Heavy Guns, on Small-port Carriages and Platforms	
Lists of Small-Arms, &c., in use in the British Service	
On the Instruction of the Men of the Field Artillery in laying Guns. Translation from the German	
Final Report of Experiments made with Bashforth Chronograph 1879–80.....	
Foreign Field Artillery, by Dr. C. Beckerheim...	
Treatise on Military Carriages, 1879	
German Artillery: Précis of Remarks on Construction of Batteries	
Précis of Experiments contained in the Reports on Transport Trials with Siege Matériel in 1878. Translated by Capt. W. M'Clintock, R.A.	
Instructions for the Training of the Foot Artillery in Laying Ordnance. Berlin, 1879. Translated by Major Van Straubenzee, R.A.	
Report on the part taken by the Artillery in the Action near Dakka, on 15th January, 1880 ...	D. A. General, R.A., in India.
Report of the Action before Ghazni on 19th April, 1880	
Report on Experimental Practice carried out at Kandahar, by No. 6 Battery, 11th Bde. R.A.	
Artillery Operations Naga Field Force.....	
Report of the Action before Ghazni, on 23rd April, 1880	
Report of the Action at Mazina, on 28th May, 1880.....	
Report of the Action near Charasiab on 25th April, 1880	
Report of the Operations of the R.A. 2nd Kabul Field Force, from 19th September, 1879, to 28th March, 1880.....	
Report of the Action in the Hissarak Valley on 12th April, 1880	

Report of the part taken by the R.A. in the Operations under Brig.-General Doran, on 19th May, 1880	D. A. General, R.A., in India.
Report on the March of the R.A. of the Force under Lieut.-General Sir D. M. Stewart, K.C.B., from Kandahar towards Kabul, *viâ* Ghazni ...	
Despatches relating to the Operations of the Movable Column Khyber Line Force in the Lughman Valley	
Report of the part taken by the R.A. in the recent Operations near Larchipur	
Report of the part taken by the Artillery of the 1st and 2nd Divisions Northern Afghan Field Force while commanded by Colonel C. R. O. Evans	
Report on Royal Artillery in the Action near Kandahar, on 1st September, 1880	
Report on C/B, R.H.A., in the Action at Maiwand, on 27th July	
Artillery Diary during the Siege of Kandahar, from 27th July, to 1st September, 1880	
Report of the E/B, R.H.A., and 5/11 R.A., in the action near Kandahar, on 1st September, 1880	
Report by Officer Comdg. C/2, R.A., of the visit to Maiwand	
Descriptive Return of Ordnance captured in the Action before Kandahar at Baba Wali, from Sirda Ayub Khan, on 1st September, 1880 ...	
Report on Circumstances attending an Explosion of Nitro-Glycerine near Montrose, on 5th March, 1880	Sec. of State for Home Dept.
Fourth Annual Report of H.M. Inspector of Explosives	
Proceedings of the Zoological Society of London, Part IV., 1879; Parts I., II., and III., 1880	Council of the Society.
List of Vertebrated Animals of Zoological Society of London, 1879	
Catalogue of Library of Zoological Society of London	
Russian Artillery Journal Nos. 4 to 12, 1880, Nos. 1 and 2, 1881	Russian Government.
Russian Small-Arms Journal, No. 4, 1879, Nos. 1 to 3, 1880	
The Cobham Journals, by Miss Ormerod, F.M.S.	Through Meteorological Society.
On the Determination of the Vibration of Tuning Forks, by H. M'Leod and Lieut. G. S. Clarke, R.E.	Lieut. G. S. Clarke, R.E.
Catalogue of Building Materials in South Kensington Museum	H. Sandham, Esq.
Do. of Machinery, Drawings, Tools, &c., in Do.	
Do. of Ships Models, and Marine Engineering, in Do.	
Do. of Munitions of War, in Do.	

Minutes of Proceedings of the Institution of Civil Engineers, Vols. 59, 60, 61, 62	The Council.
U.S. Geological and Geographical Survey of Colorado and Adjacent Territory, 1876	Dr. F. V. Hayden.
U.S. Survey of Territories of Idaho and Wyoming	
History of North American Pinnipeds by J. A. Allen	
Letters of Admiral of the Fleet, Sir H. Codrington	Lady Bourchier.
Journal of United Service Institution of India	The Council.
Researches on Explosives, No. 2: Fired Gunpowder, by Capt. Noble and F. A. Abel, Esq., C.B.	F. A. Abel, Esq., C.B.
Abel on Explosive Agents applied to industrial purposes	
The Archæological Journal No. 146	The Council.
Examination Papers R.M. Academy, May and July, 1880	Governor R.M. Academy.
Translation of the Report of the 10th Bde. of the 10th Regiment of Artillery on the trial of Capt. Scott's System of Sighting	Captain Scott, R.E.
Handbook of Artillery for the Service of the United States, by Lt.-Col. J. Roberts, U.S.A.	Brig.-General D. Tyler, U.S.A.
Journal of United Service Institution of India	The Council.
On the Weapons, Army Organization, and Political Maxims of the Ancient Hindus, with Special Reference to Fire-Arms, by Gustav Oppert, Ph.D.	Major G. B. B. Hobart, R.A.
Report of the Examination for Admission to Staff College, June 1880	Dir.-Gen. of Military Education.
Map of Turkestan, 2 sheets	Lieut. Willock, R.E.
Caricature Sketch of Officers R.A. about 1805	Capt. Charleton.
Office Manual for Garrison Artillery	Major Phipps, R.A.
Memoirs of the Royal Astronomical Society, Vol. XLV.	Lieut. T. P. Battersby, R.A.
Rough Diary of March of "I" Battery, 1st Bde. R.A., to Kandahar, &c.	Major H. C. Lewes, R.A.
Strategos, the American Game of War, 2 vols.	Lieut. C. A. L. Totten, U.S.A.
Journal of the Royal United Service Institution	The Council.
Annual Report of the School of Musketry at Hythe for the years ending 21st April, 1879, and 21st April, 1880	Inspr.-General of Musketry.
Tegninger of Norsk Marine Artillerie Matériel, Book 4	Swedish and Norwegian Govt.
Artilleri Tidskrift, to date	
Report of Experiments on Armour Plates at Scheveningen (Netherlands) with a gun of 24 centimètres	Netherland's Government.
Netherlands Artillery Atlas. Plates 124–129, 6 sheets	
Revista Militar Espanola, to date	Spanish Government.
Proceedings of the Institution of Mechanical Engineers	The Council.
Ratnik, to date	Servian Government.

Smithsonian Contributions to Knowledge, Vol. XXII.	The Council.
Do. Miscellaneous Collections, Vol. XVI. & XVII.	
Do. Report, 1880	
Journal of the Military Service Institution of the United States, to date	The Council.
A Text Book of Military Law, by Major Gorham, R.A.	Mr. H. Whiteley, Senr.
Journal of the Royal Geographical Society	The Council.
Greenwich Magnetic and Meteorological Observations, 1878	The Astronomer Royal.
Report of Astronomer Royal to Board of Visitors June 1880	
Kane's List of Officers of the Royal Regiment of Artillery	N. E. Hamilton, Esq.
Fors Clavigera. Letter the Fifth	J. Ruskin, Esq., LL.D.
Deucalion, Part 7	
A Collection of Books, Pamphlets, Maps, &c.	Lieut.-Gen. Sir J. H. Lefroy, K.C.M.G., C.B., &c.
An Address to the Geographical Section of the British Association, Swansea, 1880, by Lieut.-General Sir J. H. Lefroy, K.C.M.G., C.B.	
A Collection of Books, Pamphlets, Maps, &c.	Major F. C. H. Clarke, R.A.

F

Books, &c., purchased.

Nouveau Dictionnaire de Geographie Universelle, par M. Vivien Saint Martin. Tome premier (A to C). Paris, 1879.
A Monograph of the Jacamars and Puff Birds, by P. L. Sclater. Parts 1 to 4.
Biologia Centrali Americana.
Zoology. Parts 2 to 9.
Botany. Parts 2 to 6.
Metallurgy, Silver and Gold. Part 1. By Dr. J. Percy.
Reglement sur le Service des Armees en Campagne, par Charles de Savoye.
Dictionnaire des Sciences Militaires, Allemand Francais, par J. F. Minssen.
Royal Engineer Field Book.
Life of Lord Lynedoch, by A. M. Delavoye.
Records of the 90th Regiment, by A. M. Delavoye.
Wave and Vortex Motion, by T. Craig, Ph.D.
Geography, Physical, Historical, and Descriptive, by Keith Johnson.
The Ibis. Vol. IV. Nos. 14 to 16. Index to 1859–76.
Statement of Moral and Matériel Progress and Condition of India during the year 1877–8.
Art in the Mountains, by H. Blackburn.
Die Feld Artillerie of Austria, Germany, England, Russia, Italy, and France, by Carl Beckerhinn.
Heat a Mode of Motion. Tyndall.
A Nautical and Technical Dictionary of English and Italian Languages, by Raffaelle Settembrini.
Stieler's Hand Atlas. 12 parts in continuation.
Jahresberichte. 1879.
Monograph of the Nectorinidea or Family of Sun Birds. Parts 11 and 12.

Encyclopædia Brittanica. Vols. XI. and XII.
A Physical Treatise on Electricity and Magnetism, by J. E. H. Gordon.
Carnet Aide Memoire de Manœuvres et de Campagne de toutes armes, par E. Costa de Serda et Capt. Litschfousse.
Birds of Europe. Parts 77 to 79.
The Sportman's Handbook, by R. Ward, F.Z.S.
305 sheets of German General Staff Atlas.
Mountain Warfare, by Major-General Shadwell, C.B.
Studies in Tactics of Infantry, by Major von Scherff.
Russia's Advance Eastwards, by C. E. H. Vincent.
Operations of the South Army in January and February, 1871.
Tactical Deductions from the War of 1870–1, by A. V. Boguslawski.
Operations of the 1st Army, by A. Von Schell.
Operations of the Bavarian Army, by Capt. H. Helvic.
Millhouse's Italian Dictionary. 2 vols.
Carnet de Renseignments à l'usage des Officiers du Genie en Campagne.
American Inventions in B. L. Small Arms and Heavy Ordnance, by C. B. Norton.
Etudes sur la Tactique de l'Artillerie de Campagne, par à Von Schell. Traduit de L'Allemand, par C. Capette.
Kostensk's Turkestan. 3 vols.
Militarische Klassiker. Parts 1 to 4.
A Monograph of the Bucerotidæ. Parts 7 and 8.
Birds of Asia. Part 32.
Supplement to the Trochilidæ or Humming Birds. Part 1.
Birds of New Guinea. Part 11.
La Guerre d'Orient en 1877–8, par un Tacticien. Parts 1 to 5.
Die Hauptwaffe von A. V. Boguslawski.
Frœschwiller, Chalons, Sedan, par A. Dugnet.
Guerre Franco-Allemand, par F. Bonnet.
War Ships and Navies of the World, by J. W. King.
Invasion of the Crimea, Vol. VI., by A. W. Kingslake.
Birds of Ceylon. Part 3.
Phillips County Maps.
Die neu Russische Taktik, von A. V. Drygalski.
Taktische Beispiele von Lettow Vorbeck.
Gurko and Suleiman Pacha, von H. Hinze.
Comprehensive Atlas of Geography, by J. Bryce.
Navire's Cuirassés de l'Angleterre de la France et de l'Allemande, par T. H. A. Tromp.
Handwörterbuch der Militär-Wissenschaften, von B. Poten.
Rôle des Localities à la Guerre, par L. Thival.
Traite de Reconnaissances Militaires, par L. A. Unger.
Manuel de la Conduite des Troupes, par C. von Widdern.
Des Marches et des Combats, par le General Berthaut.
Krieg's Telegraphie, von R. von Fischer Treuenfeld.
Clery's Minor Tactics.
Das Wehrwesen der Schweiz, von J. Feiss.
Nouvelle Geographie Universelle, par Elise Reclus. Vol. VI.
Silver's Handbook to S. Africa.
Do. Transvaal.
Frederick the Great and Seven Years' War, by F. W. Longman.
The Royal Navy, 1872–80, by W. F. Mitchell.
The Condition of Nations, by G. Fr. Kolb. Translated by Mrs. Brewer.
Dr. Smith's Smaller English-Latin Dictionary.

Carnet de l'Officier de Marine.
The Statistical Atlas of England, Scotland, and Ireland, by G. Phillips Bevan. Parts 1 to 3.
Paris et ses Fortifications, 1870–80, par Eugene Tenot.
Salmon's Higher Plane Curves.
Owen's Fossil Mammals of Australia.
How to Draw a Straight Line, by A. B. Kempe.
The Atomic Theory, by Ad Wurtz. Translated by E. Cleminshaw, M.A.
Mathematical Instruments, and how to use them, by F. E. Hulme.
Animal Life, by Karl Semper.
Geometry of Conics, by C. Taylor, M.A.
Strategos, the American Game of War, by Lieut. C. A. L. Totten, U.S.A.
The Thirty Years' War, by S. R. Gardiner.
Weather Charts and Storm Warnings, by R. H. Scott.
Report on Army Re-organization, 1881.
Reports on Army Organization.
Report of Committee on the Formation of Territorial Regiments.
Report on the Pay, Promotion, and Retirement of Officers of the Ordnance Corps, 1881.
Island Life, by A. R. Wallace.
Anthropology, by E. B. Tylor.
Arundel Society Plates. Interior of the Piccolimini Library at Siena, by Pinturicchio

G

Presentations to the Museum.

14 Fossils Stonesfield Slate	Major F. C. H. Clarke, R.A.
2 Malay Swords 2 Malay Krisés	Surg.-Major W. J. Campbell, A.M.D.
Case Shot made out of a Tin Jam Pot at Fort Ekowe, Zululand, 1879	Lieut. W. N. Lloyd, R.H.A.
1 Malay Kris	Mr. H. Whiteley, Senr.
1 Pair of Pearl Oyster Shells from Javanese and Malay Seas (old shells). 1 Pair of Large Pearl Oyster Shells, the regular mother of pearl, from Sooloo and Phillipine Seas, presented to Captain Burton-Brown, R.A., by the Sultan of Sooloo 2 Pairs of Pearl Oyster Shells, from Manaar, Ceylon 1 Pair of Pearl Oyster Shells, from Borneo 1 Set of Malay Womens Bangles Coral from Borneo Resin from the Interior of the Coal Mine at Labuan, Borneo Edible Bird's Nest Vol. VI. R.A. Institution Proceedings, partly destroyed by White Ants A valuable collection of Gems and Pearls from Ceylon, Malay Peninsula, Burmah, and Borneo, arranged under glass shade	Capt. A. Burton-Brown, R.A., F.R.A.S., F.G.S.

H

Instruments presented.

1 set (3) Weldon Range-Finders	Major J. B. Richardson, R.A.
1 Watkin's Range-Finder, with pickets, spring tape, &c., complete	Lt.-Col. Hon. A. Stewart, R.A.

I

List of Papers published in the "Proceedings" during the Year.

Further Notes on the Office Work of a Garrison Battery. By Major R. Phipps, Royal Artillery.

Explanatory Notes on Professor A. G. Greenhill's Paper "On the Rotation Required for the Stability of an Elongated Projectile." By Captain J. P. Cundill, R.A.

Appendix A of Proposed Limber System for Field Artillery. By Major W. B. E. Ellis, R.A.

Note on the Ammunition Equipment of Artillery in the Field. By Colonel W. J. Williams, R.A., C.B.

On the Rotation Required for the Stability of an Elongated Projectile. (An Elementary Demonstration.) By A. G. Greenhill, M.A., Professor of Mathematics to the Advanced Class of Artillery Officers.

On the Derivation, or Drift, of Elongated Rifled Projectiles. By A. G. Greenhill, M.A., Professor of Mathematics to the Advanced Class of Artillery Officers.

On the Motion of a Projectile in a Resisting Medium. By A. G. Greenhill, M.A., Professor of Mathematics to the Advanced Class of Artillery Officers.

The Armament of Shere Ali's Army. (Extracted from an Indian Newspaper.) Communicated by Lt.-Col. Sidney Parry, R.H.A.

An Account of the March of Lord Chelmsford's Column to Ulundi, in June and July, 1879. By Lt.-Col. J. T. B. Brown, C.B., R.A.

The French Field Guns. (Accompanied by a Table of the Field Guns of the principal European powers.) Extracted from "The Field Artillery of Austria, Germany, Russia, Italy, and France," by Captain Beckerhinn.

Short Notes on the 13-pr. M. L. Gun. By Major S. J. Nicholson, R.H.A.

Recent Experiments regarding the Bursting of Heavy Guns. (A Lecture delivered at the R.A. Institution, on 18th March, 1880, by Captain C. Orde Browne, late Royal Artillery.

Appendix B of Proposed Limber System for Field Artillery. By Major W. B. E. Ellis, R.A.

Field Range-Finding. By Lieut. E. G. Edwards, R.A.

Range-Finders. By Lieut. E. G. Edwards, R.A.

The Attack of Entrenchments by Field Artillery. By Major W. Kemmis, R.A. (The R.A. Institution Gold Medal Prize Essay, 1880.)

Annual Report and Abstract of Proceedings of a General Meeting of the Royal Artillery Institution, held on June 2, 1880; Colonel Tupper, R.H.A., in the Chair.

Journal of the March of 5/11 Heavy Field, or Elephant, Battery from Morar to Kandahar. By Major C. Collingwood, R.A.

Professional Notes Extracted from my Diary during the South African War of 1878–9. By Lieut. F. G. Slade, R.H.A.

Mountain Guns in the Naga Hills, 1879–80. By Lieut. A. Mansel, R.A.

Krupp's Meppen Experiments of 1879. By Capt. C. Orde Browne, late Royal Artillery. (Re-printed from the Journal of the Royal United Service Institution.

The Russian Field Artillery in the War of 1877–78. Translated from the "Memorial de Artillería." By Captain J. C. Dalton, R.A.

The Question of the Ammunition Equipment of Artillery in the Field. By Major S. J. Nicholson, R.H.A.

Notes on Armoured Defences. A Lecture delivered at the R. A. Institution on 29th April, 1880. By Colonel Inglis, R.E.

Italian Percussion Fuze (1879) for Field and Mountain Guns. Translated from the "Mittheilungen über Gegenstände des Artillerie-und-Genie-Wesens." By Capt. G. C. Wynne, R.A.

Adoption of a Revolver for Horse and Field Artillery in Holland. Translated from the "Revue d'Artillerie," Sept. 1880. By Capt. A. E. Turner, R.H.A.

Letter on the Weldon Range-Finder. From Major J. B. Richardson, R.A.

On the Rank, Post, and Duty of an Officer Commanding Royal Artillery in the Field. By Colonel W. J. Williams, R.H.A., C.B.

The Weldon Range-Finder. By Colonel A. W. Drayson, R.A., F.R.A.S.

Description of a Range-Finder proposed by Captain F. Roberts, R.A. By Lieut. H. C. Dunlop, R.A.

Extracts from the "Revue d'Artillerie." Translated by Capt. A. E. Turner, R.H.A.

Subaltern Officers. By Lieut. A. M. Murray, R.H.A.

Translation,—

Organ der Militär-Wissentschaftlichen Vereine; Parts VI. and VII., Vol. XX.; Parts I., II., and III., Vol. XXI. By Lieut. J. M. Grierson, R.A.

ON THE

MOTION OF A PROJECTILE IN A RESISTING MEDIUM,

(*Continued from* p. 139.)

BY

A. G. GREENHILL, M.A.,

(*Professor of Mathematics to the Advanced Class of Artillery Officers.*)

When the resistance varies as the cube of the velocity, the trajectory was shown in the "Proceedings," of the R. A. Institution, Vol. XI., p. 138, to be expressed by,—

$$p = a - \frac{1 + a^2}{\sqrt[4]{3}\sqrt{(4 + a^2)}} \frac{1}{X + A}$$

and

$$y = ax - \frac{w^2}{4gb^2} \int_0^x \frac{d\,x}{X + A},$$

where

$$x = \frac{(4 + a^2)^{\frac{1}{6}} (4 + 4a^2)^{\frac{1}{4}}}{\sqrt[4]{3}} \frac{gx}{w^2},$$

$$X = \frac{\mathrm{sn}\,x\,\mathrm{dn}\,x}{(1 - \mathrm{cn}\,x)^2}, \quad A = \frac{\mathrm{sn}\,a\,\mathrm{dn}\,a}{(1 - \mathrm{cn}\,a)^2},$$

$$b = \frac{1}{2\sqrt{2}} \frac{1 - \mathrm{cn}\,a}{k' + k\,\mathrm{cn}\,a},$$

$$a = \sqrt{\left(\frac{4 - 4b^3}{4b^3 - 1}\right)} = 2\sqrt{\frac{(\mathrm{cn}\,a - \mathrm{cn}\,2K)\,(\mathrm{cn}\,a - \mathrm{cn}\,2\omega K)\,(\mathrm{cn}\,a - \mathrm{cn}\,2\omega^2 K)}{(\mathrm{cn}\,\tfrac{4}{3}K - \mathrm{cn}\,a)\,(\mathrm{cn}\,\tfrac{4}{3}\omega K - \mathrm{cn}\,a)\,(\mathrm{cn}\,\tfrac{4}{3}\omega^2 K - \mathrm{cn}\,a)}},$$

the tangent of the inclination to the horizon at the origin, where the velocity is infinite, the modulus k being sin 15°;

and w is the terminal velocity in the medium; so that the retardation of the projectile, due to the resistance when the velocity is v, is $g\left(\frac{v}{w}\right)^3$.

Therefore, putting

$$c = \frac{k' + k\,\mathrm{cn}\,a}{1 - \mathrm{cn}\,a} = \frac{1}{2b\sqrt{2}},$$

the equation of the trajectory may be written

$$\frac{g}{w^2}(ax - y) = 2c^2 \int_0^x \frac{dx}{X + A}$$

$$= 2c^2 \int_0^x \frac{X - A}{X^2 - A^2}\, dx,$$

introducing elliptic integrals of the third kind.

Now
$$X^2 - A^2 = \frac{\mathrm{sn}^2 x\, \mathrm{dn}^2 x}{(1 - \mathrm{cn}\, x)^4} - \frac{\mathrm{sn}^2 a\, \mathrm{dn}^2 a}{(1 - \mathrm{cn}\, a)^4}$$

$$= \frac{(1 + \mathrm{cn}\, x)\,(k'^2 + k^2\, \mathrm{cn}^2 x)}{(1 - \mathrm{cn}\, x)^3} - \frac{(1 + \mathrm{cn}\, a)\,(k'^2 + k^2 \mathrm{cn}^2 a)}{(1 - \mathrm{cn}\, a)^3}$$

$$= \frac{(1 - \mathrm{cn}\, a)^3\,(1 + \mathrm{cn}\, x)\,(k'^2 + k\, \mathrm{cn}^2 x) - (1 + \mathrm{cn}\, a)\,(k'^2 + k^2 \mathrm{cn}^2 a)\,(1 - \mathrm{cn}\, x)^3}{(1 - \mathrm{cn}\, a)^3\ \ (1 - \mathrm{cn}\, x)^3}$$

and this fraction must be split up into factors (one factor being obviously $\frac{\mathrm{cn}\, x - \mathrm{cn}\, a}{1 - \mathrm{cn}\, x}$) in order to express the elliptic integrals in the normal form of the elliptic integral of the third kind, and finally to express them by Jacobi's and elliptic functions (*vide* Cayley, Durège, or Enneper's *Elliptic Functions*).

Now
$$X^2 - A^2 = \frac{z^3 - 1}{12\sqrt{3}\, b^3},$$

where
$$z = \frac{1 - \mathrm{cn}\, a}{k' + k\, \mathrm{cn}\, a} \cdot \frac{k' + k\, \mathrm{cn}\, x}{1 - \mathrm{cn}\, x};$$

and the factors of $z^3 - 1$ are $z - 1$, $z - \omega$, $z - \omega^2$, when ω and ω^2 are the imaginary cube roots of unity ($\omega = -\frac{1}{2} + i\frac{1}{2}\sqrt{3}$, $\omega^2 = -\frac{1}{2} - i\frac{1}{2}\sqrt{3}$).

And
$$z - 1 = \frac{k' + k}{k' + k\, \mathrm{cn}\, a} \cdot \frac{\mathrm{cn}\, x - \mathrm{cn}\, a}{1 - \mathrm{cn}\, x},$$

$$= \frac{c + k}{c} \cdot \frac{\mathrm{cn}\, x - \mathrm{cn}\, a}{1 - \mathrm{cn}\, x};$$

$$z - \omega = \frac{\omega\,(k' + k\, \mathrm{cn}\, a) + k\,(1 - \mathrm{cn}\, a)}{k' + k\, \mathrm{cn}\, a} \cdot \frac{\mathrm{cn}\, x - \mathrm{cn}\,(\beta + i\gamma)}{1 - \mathrm{cn}\, x}$$

$$= \frac{\omega c + k}{c} \cdot \frac{\mathrm{cn}\, x - \mathrm{cn}(\beta + i\gamma)}{1 - \mathrm{cn}\, x},$$

where
$$\mathrm{cn}\,(\beta + i\gamma) = \frac{\omega\,(k' + k\, \mathrm{cn}\, a) - k'\,(1 - \mathrm{cn}\, a)}{\omega\,(k' + k\, \mathrm{cn}\, a) + k\,(1 - \mathrm{cn}\, a)}$$

$$= \frac{\omega c - k'}{\omega c + k};$$

and similarly

$$z - \omega^2 = \frac{\omega^2 c + k}{c} \quad \frac{\operatorname{cn} x - \operatorname{cn}(\beta - i\gamma)}{1 - \operatorname{cn} x}.$$

We can prove that

$$\beta + i\gamma = \omega a, \ \beta - i\gamma = \omega^2 a;$$

for $$\operatorname{cn}(\beta + i\gamma) = \frac{\omega c - k'}{\omega c + k}, \quad \operatorname{cn}(\beta - i\gamma) = \frac{\omega^2 c - k'}{\omega^2 c + k};$$

and, therefore, if we put

$$\operatorname{cn}(\beta + i\gamma) = A + iB,$$

then $$\operatorname{cn}(\beta + i\gamma) \operatorname{cn}(\beta - i\gamma) = A^2 + B^2,$$

$$= \frac{c^2 + k'c + k'^2}{c^2 - kc + k^2}.$$

Also $$A + iB = \frac{\omega c - k'}{\omega c + k} = \frac{(\omega c - k')(\omega^2 c + k)}{c^2 - kc + k^2}$$

$$= \frac{c^2 + \frac{1}{2}(k' - k)c - kk' + i\frac{1}{2}\sqrt{3}(k' + k)c}{c^2 - kc + k^2}$$

and therefore $$A^2 - B^2 = \frac{\{c^2 + \frac{1}{2}(k' - k)c - kk'\}^2 - \frac{3}{4}(k' + k)^2 c^2}{(c^2 - kc + k^2)^2}$$

Therefore

$$\operatorname{sn}^2(\beta + i\gamma) = 1 - (A + iB)^2$$

$$= 1 - A^2 + B^2 - 2iAB;$$

and $$\operatorname{sn}^2(\beta + i\gamma) \operatorname{sn}^2(\beta - i\gamma)$$

$$= (1 - A^2 + B^2)^2 + 4A^2 B^2$$

$$= 1 - 2(A^2 - B^2) + (A^2 + B^2)^2$$

$$= 6 \frac{c^2 + \frac{1}{4} c\sqrt{2} + \frac{1}{8}}{(c^2 - kc + k^2)^2}.$$

Similarly

$$\mathrm{dn}^2(\beta+i\gamma) = k'^2 + k^2(A+iB)^2$$

$$= k'^2 + k^2(A^2-B^2) + 2ik^2AB:$$

and

$$\mathrm{dn}^2(\beta+i\gamma)\,\mathrm{dn}^2(\beta-i\gamma)$$

$$= \{k'^2 + k^2(A^2-B^2)\}^2 + 4k^4A^2B^2$$

$$= k'^4 + 2k^2k'^2(A^2-B^2) + k^4(A^2+B^2)^2$$

$$= \frac{(c-\frac{1}{4}\sqrt{2})^2(c^2+\frac{1}{4}c\sqrt{2}+\frac{1}{8})}{(c^2-kc+k^2)^2}.$$

Therefore—(Durège, *Elliptische Functionen*, p. 286)—

$$\mathrm{cn}\,2\beta = \mathrm{cn}\,(\beta+i\gamma+\beta-i\gamma),$$

$$= \frac{\mathrm{cn}(\beta+i\gamma)\,\mathrm{cn}(\beta-i\gamma) - \mathrm{sn}(\beta+i\gamma)\,\mathrm{sn}(\beta-i\gamma)\,\mathrm{dn}(\beta+i\gamma)\,\mathrm{dn}(\beta-i\gamma)}{1-k^2\,\mathrm{sn}^2(\beta+i\gamma)\,\mathrm{sn}^2(\beta-i\gamma)}$$

$$= \frac{(c^2-kc+k^2)(c^2+k'c+k'^2) - \sqrt{6}(c^3-\frac{1}{32}\sqrt{2})}{(c^2-kc+k^2)^2 - 6k^2(c^2+\frac{1}{4}c\sqrt{2}+\frac{1}{8})}$$

$$= \frac{c-k'}{c+k}, \text{ after reduction,}$$

$$= \mathrm{cn}\,a.$$

Similarly

$$\mathrm{cn}\,2i\gamma = \frac{(c^2-kc+k^2)(c^2+k'c+k'^2) + \sqrt{6}(c^3-\frac{1}{32}\sqrt{2})}{(c^2-kc+k')^2 - 6k^2(c^2+\frac{1}{4}c\sqrt{2}+\frac{1}{8})};$$

and, therefore, dividing numerator and denominator by the common factor $c+k$,

$$\mathrm{cn}\,(2\gamma, k') = \frac{c^3+\frac{3}{4}c^2\sqrt{2}-\frac{3}{4}c^2\sqrt{6}+\frac{1}{4}c-\frac{1}{8}\sqrt{2}}{c^3+\frac{3}{4}c^2\sqrt{2}+\frac{3}{4}c^2\sqrt{6}+\frac{1}{4}c-\frac{1}{8}\sqrt{2}},$$

$$\frac{1-\mathrm{cn}\,(2\gamma, k')}{1+\mathrm{cn}\,(2\gamma, k')} = \frac{\frac{3}{4}c^2\sqrt{6}}{c^3+\frac{3}{4}c^2\sqrt{2}+\frac{1}{4}c-\frac{1}{8}\sqrt{2}}$$

$$= \frac{\frac{3}{4}c^2\sqrt{6}}{\left(c-\frac{1}{\sqrt{4}}\sqrt{2}\right)\left(c+\frac{1}{2}\sqrt{2}\right)^2}$$

$$= \frac{1-\mathrm{cn}\,a}{1+\mathrm{cn}\,a}\left(\frac{k'+k\mathrm{cn}\,a}{k'-k\mathrm{cn}\,a}\right)^2,$$

equivalent to

$$\frac{1-\mathrm{sn}\,(2\gamma, k')}{1+\mathrm{sn}\,(2\gamma, k')} = \frac{1-\mathrm{sn}\,a}{1+\mathrm{sn}\,a}\quad\left(\frac{1-\alpha\,\mathrm{sn}\,a}{1+\alpha\,\mathrm{sn}\,a}\right)^2$$

where $\alpha = \frac{1}{2}(\sqrt{3}-1)$; and therefore by means of the second cubic transformation (Cayley, *Elliptic Functions*, p. 186) $\mathrm{M} = \frac{1}{\sqrt{3}}$; and by reason of the modular equation,

$$\sqrt{k\lambda} + \sqrt{k'\lambda'} = 1:$$

since, if $\lambda = k'$, $\lambda' = k$;

then $2\sqrt{kk'} = 1$;

or $2kk' = \frac{1}{2} = \sin 30°$;

and $k = \sin 15°$, $k' = \sin 75°$, as required.

Therefore we may put

$$2\gamma = \sqrt{3}a, \text{ and } 2\beta = -a,$$

so that $\beta + i\gamma = -\frac{1}{2}a + i\,\frac{1}{2}\sqrt{3}a = \omega a,$

and $\beta - i\gamma = -\frac{1}{2}a - i\,\frac{1}{2}\sqrt{3}a = \omega^2 a.$

Therefore

$$z^3 - 1$$

$$= \frac{c^3+k^3}{c^3}\quad\frac{(\mathrm{cn}\,x - \mathrm{cn}\,a)(\mathrm{cn}\,x - \mathrm{cn}\,\omega a)(\mathrm{cn}\,x - \mathrm{cn}\,\omega^2 a)}{(1-\mathrm{cn}\,x)^3}$$

and

$$X^2 - A^2 = \frac{z^3-1}{12\sqrt{3}\,b^3}$$

$$= \frac{(c^3+k^3)(\mathrm{cn}\,x - \mathrm{cn}\,a)(\mathrm{cn}\,x - \mathrm{cn}\,\omega a)(\mathrm{cn}\,x - \mathrm{cn}\,\omega^2 a)}{12\sqrt{3}\,b^3c^3\,(1-\mathrm{cn}\,x)^3}$$

$$= 2\,\frac{c^3+k^3}{(k'+k)^3}\quad\frac{(\mathrm{cn}\,x - \mathrm{cn}\,a)(\mathrm{cn}\,x - \mathrm{cn}\,\omega a)(\mathrm{cn}\,x - \mathrm{cn}\,\omega^2 a)}{(1-\mathrm{cn}\,x)^3}$$

$$= \frac{2}{(1-\mathrm{cn}\,x)^3}\quad\frac{(\mathrm{cn}\,x - \mathrm{cn}\,a)(\mathrm{cn}\,x - \mathrm{cn}\,\omega a)(\mathrm{cn}\,x - \mathrm{cn}\,\omega^2 a)}{(1-\mathrm{cn}\,a)(1-\mathrm{cn}\,\omega a)(1-\mathrm{cn}\,\omega^2 a)};$$

giving the factors of $X^2 - A^2$.

Therefore $$2c^2 \frac{X-A}{X^2-A^2}$$

$$= c^2 \frac{(k'+k)^3}{c^3+k^3} \frac{(1-\operatorname{cn} x)\operatorname{sn} x \operatorname{dn} x - (1-\operatorname{cn} x)^3 \frac{\operatorname{sn} a \operatorname{dn} a}{(1-\operatorname{cn} a)^2}}{(\operatorname{cn} x - \operatorname{cn} a)(\operatorname{cn} x - \operatorname{cn} \omega a)(\operatorname{cn} x - \operatorname{cn} \omega^2 a)}.$$

This fraction has a quotient

$$c^2 \frac{(k'+k)^3}{c^3+k^3} \frac{\operatorname{sn} a \operatorname{dn} a}{(1-\operatorname{cn} a)^2}$$

$$= -\frac{1}{2} \frac{3c^2}{c^3+k^3} \frac{dc}{da}$$

$$= -\frac{1}{2} \frac{d}{da} \log (c^3+k^3)$$

$$= \frac{1}{2} \frac{d}{da} \log (1-\operatorname{cn} a)(1-\operatorname{cn} \omega a)(1-\operatorname{cn} \omega^2 a)$$

since $$1-\operatorname{cn} a = \frac{k'+k}{c+k},$$

$$1-\operatorname{cn} \omega a = \frac{k'+k}{\omega c+k},$$

$$1-\operatorname{cn} \omega^2 a = \frac{k'+k}{\omega^2 c+k};$$

and therefore

$$(1-\operatorname{cn} a)(1-\operatorname{cn} \omega a)(1-\operatorname{cn} \omega^2 a) = \frac{(k'+k)^3}{c^3+k^3}.$$

Also $$\frac{dc}{da} = -\frac{(k'+k)\operatorname{sn} a \operatorname{dn} a}{(1-\operatorname{cn} a)^2};$$

and

$$\frac{\operatorname{sn} a \operatorname{dn} a}{(1-\operatorname{cn} a)^2} = \frac{\operatorname{sn} \omega a \operatorname{dn} \omega a}{(1-\operatorname{cn} \omega a)^2} = \frac{\operatorname{sn} \omega^2 a \operatorname{dn} \omega^2 a}{(1-\operatorname{cn} \omega^2 a)^2}$$

$$= \sqrt{\left(\frac{1-b^3}{12\, b^3 \sqrt{3}}\right)},$$

the value of $$\sqrt{\left(\frac{z^3-b^3}{12\, b^3 \sqrt{3}}\right)} \quad \text{or} \quad \frac{\operatorname{sn} x \operatorname{dn} x}{(1-\operatorname{cn} x)^2}$$

when $$z^3 = 1, \text{ or } z = 1 \text{ or } \omega \text{ or } \omega^2,$$

and therefore when $$x = a \text{ or } \omega a \text{ or } \omega^2 a.$$

The remainder of the fraction must be split up into partial fractions of the form

$$\frac{A\,\mathrm{sn}\,x\,\mathrm{dn}\,x - A'}{\mathrm{cn}\,x - \mathrm{cn}\,a} + \frac{B\,\mathrm{sn}\,x\,\mathrm{dn}\,x - B'}{\mathrm{cn}\,x - \mathrm{cn}\,\omega a} + \frac{C\,\mathrm{sn}\,x\,\mathrm{dn}\,x - C'}{\mathrm{cn}\,x - \mathrm{cn}\,\omega^2 a}.$$

To determine A and A', multiply up by $\mathrm{cn}\,x - \mathrm{cn}\,a$, and put $x = a$; therefore

$$A = c^2\frac{(k'+k)^3}{c^3+k^3}\frac{1-\mathrm{cn}\,a}{(\mathrm{cn}\,a - \mathrm{cn}\,\omega a)\,(\mathrm{cn}\,a - \mathrm{cn}\,\omega^2 a)}$$

$$= c^2\frac{(k'+k)^3}{c^3+k^3}\frac{\frac{k'+k}{c+k}}{\left(\frac{k'+k}{\omega c+k} - \frac{k'+k}{c+k}\right)\left(\frac{k'+k}{\omega^2 c+k} - \frac{k'+k}{c+k}\right)}$$

$$= \frac{(k'+k)^2}{(1-\omega)\,(1-\omega^2)}$$

$$= \frac{1}{3}(k'+k)^2 = \frac{1}{2};$$

and

$$A' = c^2\frac{(k'+k)^3}{c^3+k^3}\frac{(1-\mathrm{cn}\,a)\,\mathrm{sn}\,a\,\mathrm{dn}\,a}{(\mathrm{cn}\,a - \mathrm{cn}\,\omega a)\,(\mathrm{cn}\,a - \mathrm{cn}\,\omega^2 a)}$$

$$= A\,\mathrm{sn}\,a\,\mathrm{dn}\,a = \frac{1}{2}\,\mathrm{sn}\,a\,\mathrm{dn}\,a.$$

To determine B and B', multiplying up by $\mathrm{cn}\,x - \mathrm{cn}\,\omega a$, and then putting $x = \omega a$;

$$B = c^2\frac{(k'+k)^3}{c^3+k^3}\frac{(1-\mathrm{cn}\,\omega a)}{(\mathrm{cn}\,\omega a - \mathrm{cn}\,a)\,(\mathrm{cn}\,\omega a - \mathrm{cn}\,\omega^2 a)}$$

$$= c^2\frac{(k'+k)^3}{c^3+k^3}\frac{\frac{k'+k}{\omega c+k}}{\left(\frac{k'+k}{c+k} - \frac{k'+k}{\omega c+k}\right)\left(\frac{k'+k}{\omega^2 c+k} - \frac{k'+k}{\omega c+k}\right)}$$

$$= \frac{(k'+k)^2}{(\omega-1)\,(\omega-\omega^2)}$$

$$= \frac{1}{3}\omega\,(k'+k)^2 = \frac{1}{2}\omega;$$

$$B' = c^2\frac{(k'+k)^3}{c^3+k^3}\frac{(1-\mathrm{cn}\,\omega a)^3}{(\mathrm{cn}\,\omega a - \mathrm{cn}\,a)\,(\mathrm{cn}\,\omega a - \mathrm{cn}\,\omega^2 a}\frac{\mathrm{sn}\,a\,\mathrm{dn}\,a}{(1-\mathrm{cn}\,a)^2}$$

$$= c^2\frac{(k'+k)^3}{c^3+k^3}\frac{(1-\mathrm{cn}\,\omega a)\,\mathrm{sn}\,\omega a\,\mathrm{dn}\,\omega a}{(\mathrm{cn}\,\omega a - \mathrm{cn}\,a)\,(\mathrm{cn}\,\omega a - \mathrm{cn}\,\omega^2 a)}$$

$$= B\,\mathrm{sn}\,\omega a\,\mathrm{dn}\,\omega a = \frac{1}{2}\omega\,\mathrm{sn}\,\omega a\,\mathrm{dn}\,\omega a,$$

Similarly $$C = \frac{1}{2}\omega^2; \quad C' = \frac{1}{2}\omega^2 \operatorname{sn}\omega^2 a \operatorname{dn}\omega^2 a.$$

Therefore $$\frac{g}{w^2}(ax - y)$$

$$= 2c^2 \int_0^x \frac{X - A}{X^2 - A^2}\,dx$$

$$= \frac{1}{2}\,x\,\frac{d}{da}\log\,(1 - \operatorname{cn} a)(1 - \operatorname{cn}\omega a)(1 - \operatorname{cn}\omega^2 a$$

$$+ \frac{1}{2}\int_0^x \frac{\operatorname{sn} x \operatorname{dn} x - \operatorname{sn} a \operatorname{dn} a}{\operatorname{cn} x - \operatorname{cn} a}\,dx$$

$$+ \frac{1}{2}\omega \int_0^x \frac{\operatorname{sn} x \operatorname{dn} x - \operatorname{sn}\omega a \operatorname{dn}\omega a}{\operatorname{cn} x - \operatorname{cn}\omega a}\,dx$$

$$+ \frac{1}{2}\omega^2 \int_0^x \frac{\operatorname{sn} x \operatorname{dn} x - \operatorname{sn}\omega^2 a \operatorname{dn}\omega^2 a}{\operatorname{cn} x - \operatorname{cn}\omega^2 a}\,dx.$$

Now $$\int_0^x \frac{\operatorname{sn} a \operatorname{dn} a}{\operatorname{cn} x - \operatorname{cn} a}\,dx$$

$$= \int_0^x \frac{\operatorname{sn} a \operatorname{cn} x \operatorname{dn} a + \operatorname{sn} a \operatorname{cn} a \operatorname{dn} a}{\operatorname{cn}^2 x - \operatorname{cn}^2 a}\,dx;$$

of which

$$\int_0^x \frac{\operatorname{sn} a \operatorname{cn} x \operatorname{dn} a}{\operatorname{cn}^2 x - \operatorname{cn}^2 a}\,dx$$

$$= \frac{1}{4}\log \frac{1 - \operatorname{cn}(a + x)}{1 + \operatorname{cn}(a + x)} \quad \frac{1 + \operatorname{cn}(a - x)}{1 - \operatorname{cn}(a - x)},$$

as can easily be verified by differentiation;

for $$\frac{d}{dx}\log \frac{1 - \operatorname{cn}(a+x)}{1 + \operatorname{cn}(a+x)} \quad \frac{1 + \operatorname{cn}(a-x)}{1 - \operatorname{cn}(a-x)}$$

$$= \frac{\operatorname{sn}(a+x)\operatorname{dn}(a+x)}{1 - \operatorname{cn}(a+x)} + \frac{\operatorname{sn}(a+x)\operatorname{dn}(a+x)}{1 + \operatorname{cn}(a+x)}$$

$$+ \frac{\operatorname{sn}(a-x)\operatorname{dn}(a-x)}{1 + \operatorname{cn}(a-x)} + \frac{\operatorname{sn}(a-x)\operatorname{dn}(a-x)}{1 - \operatorname{cn}(a-x)}$$

$$= 2\,\frac{\operatorname{dn}(a+x)}{\operatorname{sn}(a+x)} + 2\,\frac{\operatorname{dn}(a-x)}{\operatorname{sn}(a-x)}$$

$$= 2\,\frac{\operatorname{dn}(a+x)\operatorname{sn}(a-x) + \operatorname{sn}(a+x)\operatorname{dn}(a-x)}{\operatorname{sn}(a+x)\operatorname{sn}(a-x)}$$

$$= 4\,\frac{\operatorname{sn} a \operatorname{cn} x \operatorname{dn} a}{\operatorname{cn}^2 x - \operatorname{cn}^2 a}.$$

Also, (Enneper, *Elliptische Functionen*, p. 215),

$$\int_0^x \frac{\mathrm{sn}\,a\,\mathrm{cn}\,a\,\mathrm{dn}\,a}{\mathrm{cn}^2 x - \mathrm{cn}^2 a}\,dx$$

$$= \frac{1}{2}\log\frac{\Theta(a+x)\,\mathrm{sn}\,(a+x)}{\Theta(a-x)\,\mathrm{sn}\,(a-x)} - x\,Z\,a;$$

and therefore

$$\int_0^x \frac{\mathrm{sn}\,a\,\mathrm{dn}\,a}{\mathrm{cn}\,x - \mathrm{cn}\,a}\,dx$$

$$= \frac{1}{2}\log\frac{\Theta(a+x)}{\Theta(a-x)} - x\,Z\,a$$

$$+ \frac{1}{4}\log\frac{1-\mathrm{cn}\,(a+x)}{1+\mathrm{cn}\,(a+x)}\,\frac{1+\mathrm{cn}\,(a-x)}{1-\mathrm{cn}\,(a-x)}\,\frac{\mathrm{sn}^2(a+x)}{\mathrm{sn}^2(a-x)}$$

$$= \frac{1}{2}\log\frac{1-\mathrm{cn}\,(a+x)}{1-\mathrm{cn}\,(a-x)}\,\frac{\Theta(a+x)}{\Theta(a-x)} - x\,Z\,a.$$

Also $$\int_0^x \frac{\mathrm{sn}\,x\,\mathrm{dn}\,x}{\mathrm{cn}\,x-\mathrm{cn}\,a}\,dx = \log\frac{1-\mathrm{cn}\,a}{\mathrm{cn}\,x-\mathrm{cn}\,a},$$

and therefore

$$\int_0^x \frac{\mathrm{sn}\,x\,\mathrm{dn}\,x - \mathrm{sn}\,a\,\mathrm{dn}\,a}{\mathrm{cn}\,x - \mathrm{cn}\,a}$$

$$= \frac{1}{2}\log\left(\frac{1-\mathrm{cn}\,a}{\mathrm{cn}\,x-\mathrm{cn}\,a}\right)^2 \frac{1-\mathrm{cn}\,(a-x)}{1-\mathrm{cn}\,(a+x)}\,\frac{\Theta(a-x)}{\Theta(a+x)} + x\,Z\,a$$

$$= \log\frac{1-\mathrm{cn}\,a}{1-\mathrm{cn}\,(a+x)}\,\frac{\Theta a\,\Theta x}{\Theta(a+x)\,\Theta 0} + x\,Z\,a$$

$$= x\,Z\,a + \log\frac{\Theta x}{\Theta 0} - 2\log\frac{\Theta_{1\frac{1}{2}}(a+x)}{\Theta_{1\frac{1}{2}}a}\,\frac{\Theta_{3\frac{1}{2}}(a+x)}{\Theta_{3\frac{1}{2}}a},$$

the functions $\Theta_1 u$, $\Theta_2 u$, $\Theta_3 u$ being respectively $\frac{1}{\sqrt{k}}\,\mathrm{H}u$, $\sqrt{\frac{k'}{k}}\,\mathrm{H}(u+K)$, and $\sqrt{k'}\Theta(u+K)$, and therefore such that

$$\mathrm{sn}\,u = \frac{\Theta_1 u}{\Theta u},\quad \mathrm{cn}\,u = \frac{\Theta_2 u}{\Theta u},\quad \mathrm{dn}\,u = \frac{\Theta_3 u}{\Theta u},$$

(Cayley, *Elliptic Functions*, *p.* 156).

Therefore, in the expression for the trajectory, $\log\frac{\Theta x}{\Theta 0}$ disappears, since

$$1 + \omega + \omega^2 = 0,$$

and, finally,

$$\frac{g}{w^2}(ax - y)$$

$$= \frac{1}{2}\,\mathrm{x}\,\left\{\frac{d}{d\mathrm{a}}\log\,(1-\mathrm{cn}\,\mathrm{a})\,(1-\mathrm{cn}\,\omega\mathrm{a})\,(1-\mathrm{cn}\,\omega^2\mathrm{a})\right.$$

$$\left. + \mathrm{Z}\,\mathrm{a} + \omega\,\mathrm{Z}\,\omega\mathrm{a} + \omega^2\mathrm{Z}\omega^2\mathrm{a}\right\}$$

$$- \log\frac{\Theta_{1\frac{1}{2}}(\mathrm{a}+\mathrm{x})}{\Theta_{1\frac{1}{2}}\mathrm{a}}\quad\frac{\Theta_{3\frac{1}{2}}(\mathrm{a}+\mathrm{x})}{\Theta_{3\frac{1}{2}}\mathrm{a}}$$

$$- \omega\log\frac{\Theta_{1\frac{1}{2}}(\omega\mathrm{a}+\mathrm{x})}{\Theta_{1\frac{1}{2}}\omega\mathrm{a}}\quad\frac{\Theta_{3\frac{1}{2}}(\omega\mathrm{a}+\mathrm{x})}{\Theta_{3\frac{1}{2}}\omega\mathrm{a}}$$

$$-\omega^2\log\frac{\Theta_{1\frac{1}{2}}(\omega^2\mathrm{a}+\mathrm{x})}{\Theta_{1\frac{1}{2}}\omega^2\mathrm{a}}\quad\frac{\Theta_{3\frac{1}{2}}(\omega^2\mathrm{a}+\mathrm{x})}{\Theta_{3\frac{1}{2}}\omega^2\mathrm{a}},$$

the equation of the trajectory.

Since $$\mathrm{Z}\mathrm{a} = \frac{d}{d\mathrm{a}}\log\,\Theta\mathrm{a}\,,$$

therefore $$\omega\,\mathrm{Z}\omega\,\mathrm{a} = \frac{d}{d\mathrm{a}}\log\,\Theta\omega\mathrm{a}\,;$$

and $$\omega^2\,\mathrm{Z}\omega^2\mathrm{a} = \frac{d}{d\mathrm{a}}\log\,\Theta\omega^2\mathrm{a}\,;$$

and therefore the coefficient of x, on the right hand side of the equation of the trajectory, may be written,—

$$\frac{1}{2}\,\frac{d}{d\mathrm{a}}\log\,(1-\mathrm{cn}\,\mathrm{a})\,(1-\mathrm{cn}\,\omega\mathrm{a})\,(1-\mathrm{cn}\,\omega^2\mathrm{a})\,\Theta\mathrm{a}\,\Theta\omega\mathrm{a}\,\Theta\omega^2\mathrm{a}$$

$$= \frac{d}{d\mathrm{a}}\left\{\log\Theta_{1\frac{1}{2}}\mathrm{a}\,\Theta_{3\frac{1}{2}}\mathrm{a} + \log\Theta_{1\frac{1}{2}}\omega\mathrm{a}\,\Theta_{3\frac{1}{2}}\omega\mathrm{a} + \log\Theta_{1\frac{1}{2}}\omega^2\mathrm{a}\,\Theta_{3\frac{1}{2}}\omega^2\mathrm{a}\right\}$$

Therefore the equation of the trajectory is

$$\frac{g}{w^2}(ax-y)$$

$$= \mathrm{x}\,\frac{d}{d\mathrm{a}}\left\{\log\Theta_{1\frac{1}{2}}\mathrm{a}\,\Theta_{3\frac{1}{2}}\mathrm{a} + \log\Theta_{1\frac{1}{2}}\omega\mathrm{a}\,\Theta_{3\frac{1}{2}}\omega\mathrm{a} + \log\Theta_{1\frac{1}{2}}\omega^2\mathrm{a}\,\Theta_{3\frac{1}{2}}\omega^2\mathrm{a}\right\}$$

$$- \log\quad\frac{\Theta_{1\frac{1}{2}}(\mathrm{a}+\mathrm{x})}{\Theta_{1\frac{1}{2}}\mathrm{a}}\quad\frac{\Theta_{3\frac{1}{2}}(\mathrm{a}+\mathrm{x})}{\Theta_{3\frac{1}{2}}\mathrm{a}}$$

$$- \omega\log\frac{\Theta_{1\frac{1}{2}}(\omega\mathrm{a}+\mathrm{x})}{\Theta_{1\frac{1}{2}}\omega\mathrm{a}}\quad\frac{\Theta_{3\frac{1}{2}}(\omega\mathrm{a}+\mathrm{x})}{\Theta_{3\frac{1}{2}}\omega\mathrm{a}}$$

$$-\omega^2\log\frac{\Theta_{1\frac{1}{2}}(\omega^2\mathrm{a}+\mathrm{x})}{\Theta_{1\frac{1}{2}}\omega^2\mathrm{a}}\quad\frac{\Theta_{3\frac{1}{2}}(\omega^2\mathrm{a}+\mathrm{x})}{\Theta_{3\frac{1}{2}}\omega^2\mathrm{a}}.$$

(To be continued.)

DESCRIPTION

OF A

VETERINARY FIELD COMPANION,

BY

LIEUT. J. HOTHAM, R.H.A.

The veterinary field companion, of which a sketch is given on page 602, is one which was made under my instructions about two years ago by the artificers of "C" Battery, "A" Bde. I have many times during the last nine years found great inconvenience while on the line of march, both in India and in England, from not being able to get a small amount of useful horse medicines in a portable form for treatment on the road.

In this country, if any medicine chest is carried at all, a very large box with very little in it is the only form obtainable as a rule. In India two very complete cases are supplied, but they are a camel's load in themselves.

On the other hand, whether in England or abroad, a small party—say a troop of cavalry, or a division of a battery of artillery—has great difficulty, when detached, in getting any medicines at all. At best a few colic draughts in soda water bottles are provided; also, perhaps, a little liniment.

I therefore had a small leather case constructed, corresponding to some extent with the "Doctor's Field Companion."

In many cases, both in warfare and in peace time, small detachments of both cavalry and artillery may be isolated without a veterinary surgeon, and often without even an experienced farrier. The officer in command may not have studied farriery, and his shoeing smiths may be young and inexperienced. To help him, I have had printed on calico and placed in the case, a list of the medicines, the size of the doses, and the purposes they are to be used for in the treatment of simple cases.

The case when full weighs about 32 lbs. It is made of leather, and might be strengthened with thin iron stays. The one I have in use,

though only roughly made by the battery artificers, has stood a long march, and a good deal of rough work and usage. It is fitted up with string glass bottles and tin cases. I have shown it to many officers of high standing in the regiment, and also to many professional men, and they have all approved of it.

It is carried in the battery on the footboard of G.S. wagon.

I append list of contents, as printed on the calico in the case.

CONTENTS OF THE VETERINARY FIELD COMPANION.

Medicines ready Compounded.

COLIC DRAUGHTS.—Two six ounce bottles, graduated to ounces.

Dose. 2 ounces mixed with 1 pint of oil (if possible) or water. If no better in two hours repeat with water.

FEVER BALLS.—For case of fever.

Dose. One. Repeat every two hours until skin acts.

PURGATIVE BALLS.—*Dose.* One. After 36 to 48 hours preparation. Not to be repeated if bowels do not act freely, and not to be given to weakly patient.

ANTI-PURGATIVE BALLS.—For cases of super-purgation.

Dose. One. No better, repeat in four hours.

DIURETIC BALLS.—For cases of thick and coloured urine.

Dose. One every other day for three or four days.

Liniments and Ointments ready Compounded.

AMMONIA LINIMENT.—For sore throats and sprains, &c. To be well rubbed in.

CARBOLIC OIL.—For sores, indolent wounds, &c.

TINCT. OF MYRRH AND ALOES.—For cuts and galls.

LEAD OINTMENT.—For cracked heels, rope galls, checks too free granulations in wounds, promotes healing.

DIGESTIVE OINTMENT.—For abraded surfaces, allays pain, stimulates.

Other Drugs in the Case.

NITRIC ETHER.—Diffusible stimulant, anti-spasmodic, used in cases of colic, fever, shivering fits, exhaustion.

Dose. 1 ounce with ½ ounce aromatic spirits ammonia, for colic add 1 drachm opium.

AROMATIC SPIRIT OF AMMONIA.—Stimulant, anti-spasmodic. For colic, fever, exhaustion, shivering.

Dose, ½ ounce with 1 ounce nitric ether.

POWDERED OPIUM.—Narcotic, anti-spasmodic. For colic, inflammation of bowels, &c., allays pain.

Dose. 1 to 1½ drachms.

NITRATE OF POTASH.—*Refrigerant and Diuretic.* For fevers, rheumatism, and urinary disorders.

Dose. 1 to 2 drachms daily.

CARBONATE OF AMMONIA.—Stimulant, antacid, anti-spasmodic. For debility, indigestion, &c.

Dose. ½ to 1½ drachms daily.

SPIRITS OF TURPENTINE.—Anti-spasmodic, diuretic. For colic, also thick urine.

Dose. ½ to 1½ ounces to 6 ounces water.

SULPHATE OF COPPER.—*Caustic, External Use.* For thrush, with Stockholm tar 1 to 8. Used alone for touching bad cracked heels, indolent sores. Checks too free granulations in wounds.

GOULARD'S EXTRACT.—*For external use.* "*Poison.*" Astringent and cooling. For bruises, sore backs, weak eyes, &c. Mixed with water 1 to 6.

Table of Weights.

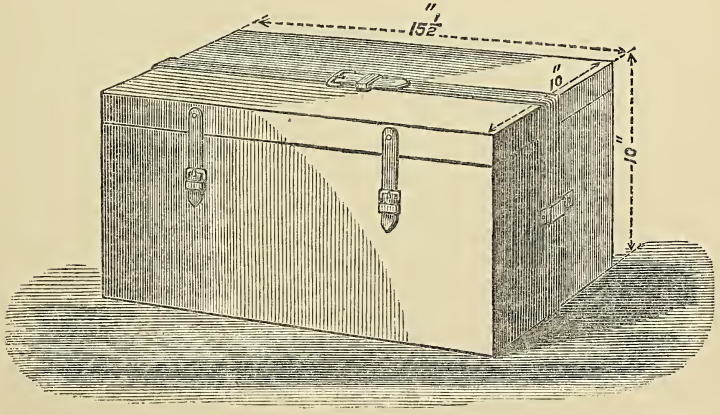
(Grains) gr. 20	make	(one scruple) ℈i.
(3 scruples) ℈iii.	make	(one drachm) ʒi.
(8 drachms) ʒviii.	make	(one ounce) ℥i.
(16 ounces) ℥xvi.	make	(one pound) ℔i.

Measures for Fluids.

60 (minims) ♏i.	make	one fluid drachm.
8 fluid drachms	make	one fluid ounce.
20 fluid ounces		one pint.

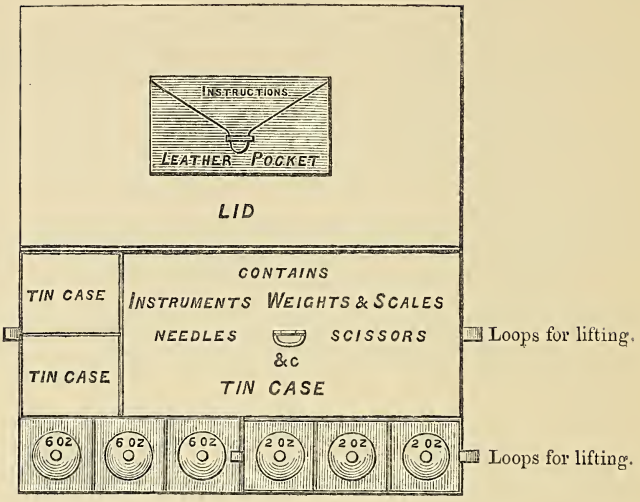
IN THE FIELD COMPANION ARE ALSO CARRIED.—1 pocket case of instruments, scales and weights, 2 graduated measures, needles and suture wires, 2 flannel and 2 linen bandages, sponge, tow, pair of trimming scissors, and a packet of pins.

I.



Dimensions ... { Length 15½ inch. Breadth 10 " Depth 10 "

II.



Plan of Vety. Field Case open with Lid.

Plan of under layer of Vety. Field Case.

Extracts from the

RUSSIAN SMALL ARM MAGAZINE.

No. 3. 1880.

BY

LIEUT. J. WOLFE MURRAY, R.A.

The miscellaneous section of this periodical contains a proposal by Captain Lapushkine, to employ a mixture of kerosine oil and mutton or beef fat as a preservative from rust. As the want of a good preservative is much felt, I quote *verbatim*:—

"I have found from a series of experiments, that kerosine (employed alone) volatilises after a time, and the weapon is thus left without any covering of oil. In order to prevent the kerosine from volatilising, I propose to add to it beef or mutton fat. A rifle smeared with this mixture may be safely put by for a whole year, and the mixture itself does not solidify.

"To prepare the mixture, take mutton or beef fat, which has been cleaned and melted down, dissolve it, and pour it into warm kerosine, then place the mixture over a gentle fire and stir it for a quarter of an hour, taking care not to let it boil.

"The proportion of fat must be so regulated that the mixture does not harden on cooling."

The advantages of this mixture are, that it thoroughly preserves the weapon from rust, and does not coagulate; it leaves no trace behind when wiped off. On the other hand it affects, but slightly, the browning of the barrels, turning them a bright cinnamon colour.

The appendix contains an article on the importance of rapid firing, and on the latest patterns of magazine rifles, and of apparatus for accelerating rifle fire.

This article is continued from previous numbers, and the diagrams necessary for the descriptions of the Metcalf and Krenka quick-loaders are attached to No. 2 of 1880; consequently no description of these apparatus is attempted. An account of the Krenka will be found in the Proceedings of the U. S. Institution, Vol. XXIV., p. 383. The writer, who was present at the Russian trials, states the advantages of Krenka's quick-loader to be briefly as follows:—

It can be cheaply, easily, and rapidly manufactured. The manipulation of it is easily acquired. In order to fit it to the rifle no change is necessary. The soldier can see all his cartridges in front of him, and thus knows how many he has expended; this is not the case with a repeater. It is easier to shoot from behind cover (lying down) with this apparatus. The men do not require to uncover any part of the body to get at the cartridge, as is the case when the pouch only is used. Ordinarily, men lying down place a heap of cartridges beside them; when the advance takes place, these cartridges are often

forgotten and lost, such loss is to a great extent obviated with the quick-loader.

Numerous experiments have been made in Russia with various forms of repeaters and quick-loading apparatus. The Krenka has been submitted to a series of tests, and the following facts regarding it have been determined by experiment.

The manipulation of the apparatus can be taught in an hour and a half. The first shot can be fired in 2 or 3 seconds after the word of command. 3 to 6 shots more per minute are obtained by using the quick-loader than by the ordinary method.

The bracket was put on and taken off 350 times, the springs did not deteriorate, and the wear was quite inappreciable.

It interferes with the handling of the rifle to an inconsiderable extent, and the additional weight does not affect the shooting, or aim.

The cartridges scarcely ever fall out of the magazine; and the magazines on no occasion fell out of the brackets. Waterproof coverings for the magazines are recommended.

The quick-loader is an advantage in firing lying down from behind cover. It is also an undoubted advantage to have (in case of surprise, or alarm, &c.) 10 rounds actually on the rifle.

To take off an empty magazine and to replace it by a full one requires 6 secs.; on an average, 10 shots can be fired in from 35 to 45 secs.

The accompanying table shows briefly the results of practice made with and without the quick-loader :—

Distance.	Position.	With quick-loader.		Without quick-loader, with Prussian pouch.		Without quick-loader, with ordinary pouch.		Remarks.
		Mean number of shots per man per minute.	Percentage of hits.	Mean number of shots per man per minute.	Percentage of hits.	Mean number of shots per man per minute.	Percentage of hits.	
200 yds.	Standing	14·65	49	9·45	74	—	—	1st Regiment.
,,	,,	10·14	48	9·13	43	—	—	2nd ,,
,,	,,	11·09	38	9·9	42	—	—	A Battalion.
,,	,,	12·46	20	12·22	15	11·39	24	,,
,,	,,	10·44	43	9·04	40	7·88	35	,,
,,	,,	12·04	58	9·24	54	6·16	67	Jäger Battalion.
,,	,,	11·64	51	9·26	46	6·61	77	,,
Mean ...		11·78	44	9·75	45	8·01	51	
Mean number of hits per man per minute.		5·18		4·39		4·09		
200 yds.	Lying down.	13·75	70	8·4	66			1st Regiment.
Mean number of hits per man per minute.		9·62		5·54				

Note.—The superiority of the practice made with the quick-loader, lying down, is worth remarking.—*Translator.*

OBSERVATIONS

BY A

SUBALTERN

ON A PAPER ENTITLED "SUBALTERN OFFICERS;"

R. A. "Proceedings," Vol. XI., No. 5,

BY

LIEUT. R. F. JOHNSON, R.A.

RECEIVED BY LIBRARY
MAY 29 1883
U.S. PATENT OFFICE

In Vol. XI., No. 5, of the "Proceedings" of the Artillery Institution, there appeared a very ably-written article, by Lieut. A. M. Murray, R.H.A., entitled "Subaltern Officers." Although I cannot pretend to a tithe of the author's ability in expressing what is to be said in clear and concise language, I venture to ask the indulgence of my readers while I endeavour to explain why I, a subaltern of the same service as Lieut. Murray, cannot agree with many of his views, and consider some of his proposals impracticable.

For convenience of reference and to avoid tiresome repetition, it is proposed to treat the subject in the same order as it is set forth in the original paper, and the paragraphs are numbered accordingly.

1, 2, 3, and 4. In the first four paragraphs is related, in a most admirable manner, the progress that has been made in the science of military training since the time of the Great Frederic: how formerly the soldier was only part of a machine, and how now so much depends on his individuality. This is a matter of history, and numberless writers of repute have proved that it is incontrovertible, but one may still doubt if everything is changed, and ask whether it is not more correct to describe the modern conditions of warfare as requiring additions to, rather than changes in, the old systems of training, and whether it is not the province of the officers to undertake this additional moral instruction, while the older physical training is left to the non-commissioned officers, rather than to attempt to do everything themselves.

5. The German system of regimental organisation is described in eulogistic terms, which make the position of a lieutenant appear most enviable for such as have the "impotent desire of men to raine." We are told that he has "a command, smaller indeed, but as independent as, that of his captain." He may have, but Colonel Kaulbars in his valuable work appears to say that the captain is responsible for everything connected with the training of his men, and uses his subalterns to assist him by giving them classes to instruct.* Perhaps the lieutenant commands his half-company as we do our divisions, but that is very different to having the independence of a German captain.

6. "In the German army there are no specialists." I quote from the original paper. Then what are the regimental officers who go through the special schools of equitation, gymnastics, &c., &c.? Again, "the artillery subalterns teach the men of their own divisions the practise and theory of gunnery." Perhaps they do in some batteries, and in some, as the captain has so much independence, the system may be simplified by grouping the men in divisions according to their service; but Colonel Kaulbars† describes a system very like that of the infantry, and an Italian officer,‡ who has written later, found the same still in force.

If the German officers are not troubled with such trivial duties as asking if the men have any complaints to make about their food, may it not be attributed to the relegating such duties to the non-commissioned officers, or to the futility of the German soldiers making any complaints? If such duties are irksome, one must remember the words of H.R.H. the Duke of Cambridge, quoted later on by Lieut. Murray:—"Remember, then, gentlemen—and these shall be my last words to you—no detail is too small for a subaltern officer."

7. To cavalry and infantry officers is left the task of defending their own regimental system, for it has very little similitude to ours. If they do not do so, it will not be from want of ability.

---

* Speaking of the recruits of a company,—"Le capitaine confie le poste d'instructeur à celui de ses lieutenants qui lui paraît le plus apte à cet emploi. Ce lieutenant dirige alors l'instruction des recrues, sous la surveillance immédiate du capitaine."

Speaking of the older classes, before the recruits are in the ranks,—"C'est donc au capitaine à diriger ceux-ci de façon à préparer de son mieux ses hommes pour les manœuvres de printemps * * * les hommes, réunis en petits groupes sont exercés à la pratique du service de campagne sous la direction des lieutenants à l'instruction desquels ces exercices sont surtout destinés."

Speaking of the training after the recruits are in the ranks,—"Quoiqu'il en soit, les hommes sont généralement, d'après l'etendue de leurs connaissances, répartis en trois classes * * * Habituellement, chaque classe est confiée à un officier, ou, à defaut, à un sons officier intelligent. Dans ce dernier cas, un officier a la direction générale des cours et fait lui-même les plus importants, tels que ceux portant sur la théorie du tir et le service en campagne."

Translated from Col. Kaulbars, in the "Bulletin de la Réunion des Officiers," 14th and 28th April, 1877.

† Le capitaine commandant est responsable de l'instruction de sa batterie à tous les points de

We are told, and most rightly told, that the exercise of responsibility begets self-reliance. Of course it does, the only question is as to that necessity—a limit. Lieut. Murray wants more space; some of us are content with our present domain, and think it large enough. Their training has doubtless done much for the Germans, but, in 1870, it appeared to lead them into most perilous positions; where they were at least within measurable distance of disaster and often suffered fearful slaughter, and whence they escaped owing much to the mistakes of their enemies.

8. I must most emphatically protest against the description, (given in this paragraph of the original paper), of the state of organisation in our own regiment being taken as one in any way fair. Such a state of things could only be produced by the violation of regimental orders, and by a disregard for the regimental system; and, whatever may have been the author's intention, cannot but reflect injuriously on the officers who have produced it. If the "Proceedings" were only read by ourselves, the whole statement might be allowed to pass without comment, but they are read by many others, to whom this picture, drawn by one of ourselves, is likely to give a very poor idea as to the regiment's efficiency. The batteries, indeed, are so scattered over the world, that one cannot deny with certainty that there may exist a few, in which the subalterns have been reduced to the position, we are told is occupied by the great majority; still, I will venture to say that they are the few exceptions, and that much may be attributed either to the

---

vue, et par suite, c'est à lui regler comme il l'entend ces exercices tant des recrues et des volontaires que des autres soldats."

"Le premier lieutenant de la batterie fait aux sons-officiers un cours sur les devoirs de leur grade, le service du chef de pièce et la manière de conduire le tir des bouches à feu."

"Tous les hommes de recrue d'une batterie sont confiés à un officier expérimenté."

"L'instruction à cheval est donnée par les plus anciens lieutenants à la classe modèle et par les plus jeunes à toutes les autres."

"On charge du dressage (des chevaux) les meilleurs cavaliers de la batterie sous la surveillance d'un officier expérimenté, habituellement le plus anciens."

Translation from Col. Kaulbars, in the "Bulletin de la Réunion des Officiers," 11th Aug. 1877.

‡ "Le capitaine a toute latitude pour choisir son mode d'instruction, pourvu qu'il atteigne le but proposé; il détermine la progression, répartit les travaux, ordonne l'emploi du temps, comme bon lui semble. Il est secondé par ses officiers chargés, le lieutenant ordinairement, mais non d'une façon absolue, des sous-officiers et des anciens artilleurs; le sous-lieutenant le plus ancien en grade, des hommes ayant plus d'une année de service, et l'autre sous-lieutenant des recrues. Le capitaine dirige, surveille, et corrige, tout en laissant une certaine latitude à ses officiers."

Translation in the "Bulletin de la Réunion des Officiers," 5th March, 1881.

inefficiency, or to the want of firmness of character,* of their divisional officers themselves.

It is very hard to understand Lieut. Murray's objections to Orderly Officers, for such an abuse of the system as he describes is unknown to me. When a division has paraded as a division, its officer, if present with the battery, has always, as far as my experience goes, been with it. In the batteries I have served in, the orderly officer has always referred men to their own officers, and has been very careful not to needlessly interfere with divisions other than his own. It would not have been pleasant for him if he had.

Is the division never to drill without its own subaltern looking on? Are officers never to have a day's hunting or shooting? Are they eternally to be superintending the drilling of a gun detachment of two men, the instruction of three in forming fours, or the explanation of the mysteries of the sword exercise to their shoeing-smith? If so, then they in truth will soon look outside their profession for employment.

In the systems of training different armies, many allowances have to be made for the national characteristics of the men; surely some may be made for those of the officers?

The horses of a battery have to be exercised, the orderly officer takes them out; one, perhaps two subalterns get a days fishing; the bond of union between them and their men is broken, the gulf of etiquette is widened! So runs the tale. Well might Terence say,—

"*Nihil est quin male narrando possit depravari!*"

9. The practical proposal to remedy all the evils supposed to exist—one very easy to make, and one which may appear at first sight very easy to carry out—is to carry on all duties and instruction by divisions under their own subaltern officers. Let us see what this means.

I think, if the state of a division of a field battery be carefully analysed, that it will be found in all cases that the squads of the different classes of the various drills consist of from 1 to 9 men each, and that on any particular day 5 or 6 is the number actually available for instruction in the largest classes, except perhaps those for theoretical instruction and for marching drill. In all there are about 18 classes. The instructors available under most favourable circumstances would be the lieutenant, two sergeants, and one rank and file non-commissioned officer. Now, the lieutenant could not instruct a class at the same time as the others, or he would be unable to supervise them, and as the rank and file non-commissioned officer could not be considered to have his education complete, while one of the sergeants

* Of course, I am only speaking of the present. In years gone by a different system may have prevailed.

would be occasionally away on other duties, the average number of classes that could be instructed at a time would be two. At this rate, taking into consideration the usual interruptions met with, some amount of time would be taken to get through the squads, and one drill a week each might be thought rather a sanguine estimate to calculate on. If the number of classes were reduced, the advanced men would have to be kept back, and so lose interest in getting on, or backward men would have to be hurried on, and would not thoroughly grasp what they are taught. Of course, if all fatigues, &c., were done by divisions, so as to have two divisions for drill and one for fatigue, the numbers available for each class would be increased; but often two divisions would be for fatigue, and great inconvenience would always be caused, while in many stations the plan would be utterly impossible to carry out.

It appears, too, a waste of time and power to divide the first and second classes at gun drill in a battery of—let us say—12 men each, which two sergeants superintended by one officer can most efficiently instruct, into six squads, of a varying strength of from three to six, requiring six sergeants and three officers. It may be urged that exceptions could be made in the case of very small classes, and that the divisional officers could make arrangements for the temporary amalgamation of their small squads, but I cannot but think that, if once such exceptions were allowed, necessity and convenience would quickly make them the rule.

If our climate were regular, if our inspections were always at the same time of year, if our parades took place on fixed days of the week, if our divisions were half batteries, if our recruits joined in large batches at regular intervals, if all our sergeants were good drills, and all our subaltern officers experienced, and if we had conscription, then the plan proposed might be practical, but even then it might not be the best for economizing labour or for obtaining the desired result.

10. Here again the author's experience seems to have been different to mine, for I have always thought that, when an officer was present, the sergeant-major never confined men without reference to him, except in cases of drunkenness; and also that, when a man has been charged with any but trivial crimes, the officer of the division has been present at the orderly room, and the Major has made any enquiries of him that may have been necessary.

As a subaltern myself I think we have already enough power in the ability to refuse recommendations for leave, &c. If these means are made use of consistently no further penal powers are required, and no record of small derelictions is kept against the men.

The relations between the men of a battery are of too intimate a

character for the three divisions to be controlled with different degrees of severity, and uniformity could not be secured, for although the commanding officer would know how many punishments Lieut. M. inflicted, he could never be sure how many men Lieut. N. let off.

It may be that the exercising of penal powers, &c., would force the growth of experience of the youthful subaltern, but forced plants are not famed for endurance, and are apt to exhaust the soil in which they grow. There is, or used to be, an old saw painted on the walls of the dining hall of the Royal Military Academy, which ran as follows:— "Through obedience learn to command." The rank and file would probably say that the duration of an officer's service as a subaltern was none too long for him to learn obedience.

I cannot see how the ability to give 3 days' C.B., could make us take more interest in our men than most of us do at present; and as to our being brought more into contact with them, and so checking the want of judgment and the inconsiderateness of the young non-commissioned officers, it must be remembered that these latter, having very little more service than the men, must find it very difficult to assert their authority, and that the least sign of distrust on the part of the officers will make it quite impossible for them to do so. The same moral can be pointed here as in the story of Col. Kaulbars of the German Captain who lived far from the barracks for fear of interfering with his subordinates.

11. As to whether the commanding officers would be relieved of any work by the system proposed, it is for them to say if they think so; but it seems necessary to bear in mind, that there is an unanimous opinion in all armies that the battery is the sole unit for artillery. When large masses are manœuvring, a collection of such units is advantageous, but subdivisions of them should only be used when circumstances render any other course impossible. If we recognise this principle, it does not appear advisable to train the officers of a battery to think only of their own divisions, or the men to look only to their own subordinate commanders for guidance. There is a great difference between being occasionally intrusted with authority, and always enjoying independence. Safety lies in neither extreme.

12. It is with great diffidence that one ventures to say anything in favour of the employment of a class of instructors which "has been condemned by nearly everyone whose opinion is really worth having," but there would be no pleasure in expressing an opinion if everyone agreed with it, so I trust to be forgiven for trying to express mine on the question of "specialists."

The manufacture of soldiers somewhat resembles all other manufactures, and in all of these the secret of cheapness (*i.e.*, the saving of

time and of labour), and of uniform success, is to use machines for the making of each of the different parts, especially adapted for the work. The parts are then collected and put together by skilled workmen under the eye of the master. Our machines for forming the details of the soldier are the specialists, and we officers are the foremen of shops and the skilled workmen who see that the parts are properly turned out, and form them into tactical units. A battery organised on the proposed system of separate divisions can only be likened to a watch composed of three small ones made in all their details by three inexperienced workmen. The master watchmaker would find much trouble in fitting the parts together, and if he succeeded, a watch with three mainsprings and three sets of wheels within wheels would very soon be out of order.

After all, it would seem that the objections to "specialists" are more theoretical than practical. If the riding master fitted the saddlery and harness, arranged the teams and the horses for riding drills, &c., he would be decidedly in the way, but at present he only ensures uniformity by generally superintending the instruction by the rough-riders of batteries, when they happen to be stationed at the head quarters of a brigade. If these officers did not exist, subaltern officers would have to go through the schools of instruction themselves, and whatever might be their instructional duties afterwards, by natural selection some would become riding masters, some gunnery instructors, some theoretical artillerists, in fact all "specialists." And who would perform their duties, and what would become of their divisions while they were away?

Again, with regard to rough-riders and the lower ranks of "specialists;" if the subalterns are not to become drill sergeants, the non-commissioned officers must be the immediate instructors of the men, and are all of them admirable Crichtons, capable of imparting instruction in all branches of drills equally well? There can surely be no doubt that a man of moderate education will instruct better in the particular subject he has been trained to, and thoroughly understands, than in many of which he can only have a fair smattering.

One gladly admits "as a general rule that the lower the decentralisation is carried, the better the work is done;" but in the work of instruction with the aid of moderate brain power, the decentralisation should be that of the subjects and instructors rather than of the classes and instructed.

I regret that, in his wish to advocate what he considers a better system than the one in vogue, Lieut. Murray should have depicted the possible results of the latter on his brother subalterns in such sombre colours; but in the same number of Proceedings*, a brighter picture,

* On the rank, post, and duty of an O. C., R. A., in the field, by Col. W. J. Williams, R.H.A., C.B.

both of the system and of us, is drawn, which I should not like to mention, if it were not by the pen of one of our own senior officers.

"The subaltern officers of horse and field artillery are excellent, they are trained to be much with their divisions, and to be proud of their work in all its thoroughness and its smartness, and they have over other subalterns the advantage of a distinct charge and a responsibility."

In conclusion, I beg to apologize for the frequent use of the first person singular. What is written is the result of my own experience, and, without making more enquiries than are at present possible, it would be presumptuous to offer my own opinions as those of the majority of the junior officers of the regiment.

COMPLETE LIST OF

PERSONAL AND OFFICIAL EQUIPMENT

FOR SPECIAL SERVICE,*

BY

COLONEL F. E. COX, R.E.

(Reprinted by permission.)

List of clothes and articles carried on the person when proceeding to base of operations, many of which will be transferred to the store trunk, to be left at the base.

No.	Article.	No.	Article.
1	Hat or cap.	1 pr.	Socks.
1	Coat.	1 pr.	Gloves.
1	Vest.	1	Pocketkerchief.
1 pr.	Trousers.	1	Notebook.
1 pr.	Boots.	1	Purse, with £5 to £10 cash.
1	Cravat.	1	Pencil.
1	Shirt.	1	Pouch bag with strap.
1 pr.	Drawers.	1	Railway time table.
1	Collar.	1 pr.	Braces.
1	Money belt—£100 in gold.	1	Signet ring with crest and motto or initials.
1	Flannel vest.	1	Pocket knife and piece of string.

One pair of straps for greatcoat, railway rugs, &c., to be left at base.

No.	Article.	No.	Article.
1	Greatcoat.	1	Umbrella.
1	Mackintosh.	1	Stick.
1	Railway rug.		

Hat Box, to be left at base.

No.	Article.	No.	Article.
1	Hat.	3	Collars.
1	Travelling cap.	3	Pocketkerchiefs.
1	Hat brush.		

* This list was prepared by Colonel Cox on being ordered for special duty in Montenegro, in 1878.

Two small leather portmanteaus, with strong water-proof covers, fitted with handles and two iron *D's*, or eyes, to facilitate carriage by pack transport. Each measuring 1′ 9″ × 1′ 2″ × 1′, and weighing 40 lbs. when packed complete.

No. 1 Portmanteau.

No.	Article.	No.	Article.
	Bottom.	2	Boxes pills, ea: Rhub. 3 gr. Ipec., ½ " Ginger, ½ "
1 pr.	Spare braces.		
2	Tape bands.	1	Box, quinine pills, ea: 3 gr.
4 pr.	Gloves, black, white, and colored.	1 pr.	Boothooks, long.
1	Housewife.	1	Bootjack, folding.
1	Piece of new flannel, 1 yard.	1	Dressing-gown.
1	Looking-glass, folding.	1 pr.	Slippers.
1	Shaving case, containing— 2 razors, 2 pr. scissors, 1 knife, 1 corkscrew, 1 pr. spectacles, 1 rule, 1 hair brush and comb, 1 pencil, 1 roll thread, 1 packing needle, 1 box pencil leads, 1 piece indiarubber, 1 toothpick (silver), 1 tin box of watch glasses, 1 piece cotton wool, 1 piece lint, 1 plaister, 1 box of studs, &c.	1	Night-shirt.
			Top.
		4	White shirts.
		6	" collars.
		2 pr.	Drawers, calico.
		1 pr.	" merino.
		1	Vests, flannel.
		3 pr.	Socks, merino.
		3	Towels.
1	Clothes brush.	2	Cravats, washing.
1	Tin box of matches, wax.	1	Tie, black.
2	Hair brushes and comb.	1	Belt, cholera.
1	Pencil case and leads.	1	" riding.
1	Bottle tooth powder.	1 pr.	Boots, elastic, side.
1	Tooth brush.	3 pr.	Socks, worsted.
1	Sponge in water-proof bag.	2	Kerchiefs, silk.
1	Soap in box.	6	" white.
3	Towels.	3	Dessert spoons, electro.
1 pr.	Merino socks.	3	Tea " "
3	White "	3	Egg " "
1	Notebook.	2	Salt " "
1	Candle lamp.	1	Mustard " "
12	" in box.	3	Forks, electro.
1	Packet papier de rebut (100).	1 pr.	Carver and fork.
		3	Knives.

No. 2 Portmanteau.

No.	Article.	No.	Articles.
	Bottom.	2	Towels, 1 bath, 1 small.
1	Despatch box, 1′ 2″ × 10″ × 4″, containing—	3 pr.	Winter socks.
		2 pr.	Merino drawers.
	Orders and instructions, 1 seal, 1 cheque book, 100 visiting cards, 2 account books, 50 pens, 3 sealing wax, 4 pencils, 1 box matches, 2 pieces rubber, 1 taper, 1 bottle of ink, 1 ruler, 1 penknife, 1 piece tape, 5 qr. note, 1 qr. foolscap, 50 envelopes, note, 12 envelope, sdemy, 25 envelopes, foolscap, ½ qr. blotting, 2 small bags for money, 1 pocket compass, 2 boxes pills, rhubarb, 1 box pills, quinine, 1 box moist colors, 1 paper cutter.	2	Pieces of soap.
		1	Telescopic cup.
		1	Packet papier de rebut, 100.
			Top.
		1	Washleather vest.
		1 pr.	Lined leather gloves.
		1	Scarf, mouse colour.
		2	Flannel lining to vests.
		3 pr.	Worsted socks, thick.
		2	Silk pocketkerchiefs.
		1 pr.	Mittens, red.
1	Notebook.	4	White shirts.
1	Prayerbook.	4	" collar.
1	Bible.	3 pr.	" socks.
1	Map, folding, of country.	3	Towels (1 bath).
1	Telescope, with straps.	6	White pocketkerchiefs.
1	Prismatic compass and straps.	1 pr.	Gloves, colored.
1	Binocular.	1	Silk nightcap.
1	Sketching pad.	2 pr.	Merino socks.
1	Small spirit lamp and half-pint of spirits.	1	Kummer bund, or cholera belt.
1	Watch in case.	2	Vests, flannel.
1	Cigar case, 100 cigars, 100 lights.	1	Shirt, night.
1	Cigarette holder and case.		

One waterproof valise, cylindrical when packed complete. Length, 3′ 3″; diameter, 1′ 2″, and weighing, when packed for transport as detailed, 55 lbs.

No.	Article.	No.	Article.
1	Portable bedstead, in cover, complete.	1	Waterproof bucket.
1	Table, small, folding.	1	〃 sheet.
1	Chair or stool, 〃	1	Regulation waterproof coat and cape.
1	Thin hair mattrass.	1	Pijammas, flannel, or shirt cloth, for sleeping.
1	Hair pillow.		
1	Cushion, waterproof, air.	1	Coat, flannel, or shirt cloth, for sleeping.
1	Hooks on strap for tent pole.		
2	Blankets.	1	Regimental greatcoat and cape. (On arriving at base will be transferred to store trunk.)
1	〃 brown, for cover.		
1	Waterproof basin.		
1	Stand for ditto, folding, and annular tray.	1	Pillow case.
		1	Union Jack flag.

One overland trunk, 3′ 3″ × 1′ 4″ × 1′ 2″, interior measurement, with waterproof cover, containing (with other details as per list) :—

1 Airtight tin case for uniform.
1 Cocked hat or helmet, with plume in tin box. (Will be left at base in trunk.)
1 Sword in waterproof cover. (Will be carried on person.)

The cubic content is about 5 ft., and weight when packed about 00 lbs. (To be left at the base.)

No.	Article.	No.	Article.
			The following will be left in overland trunk at the base :—
1	Notebook and pencil.		
1	Sword in waterproof cover.	1	Airtight tin box for uniform.
1	〃 suspender.		1 forage cap.
1	Cocked hat or helmet, and plume in tin box.		1 tunic.
			1 pr. gold-laced trousers.
1	Revolver in box, and 25 cartridges (the box to be left at base).		1 pr. dress boots.
			1 pr. 〃 spurs.
1	Revolver belt with buckle and pouch.		1 cross belt and pouch.
1 pr.	Regimental knee boots.		1 sword belt.
1 pr.	Butcher 〃		1 sabretache and slings.
1	Undress patrol jacket.		2 pr. white gloves.
1 pr.	〃 pantaloons.	1	Evening suit, plain clothes
1	Vest, red.	1	Morning suit, thick cloth, plain clothes.
1 pr.	Hunting spurs, gilt.	1	〃 summer cloth, plain clothes.
1	Morning suit, summer cloth, 2nd quality. In wear to the base, and put into the trunk when undress regimentals are taken out.	2 pr.	Silk socks.
		6	White ties.
		6	White shirts.
		3	Washing vests, summer.
500	Papier de rebut.	6	Collars.
3	Cloth shirts.	2	Night shirts.
		1	Greatcoat.
		1 pr.	Sidespring boots.
		2	Ties, black silk.
		3	Summer cravats.

One saddlery box, deal, with hinges and lock, and lined with zinc. (The box to be left at the base, and contents carried on.)

No.	Article.	No.	Article.
2	Suits, clothing, with hoods and rollers.	2	Double bridles, head stalls, and reins complete.
2	Head stalls, and reins for stable, which can be used to picket also.	2	Bits.
2	Blocks.	2	Bridoons.
2	Knee caps.	2	Curb chains.
2	Watering bridles and snaffles.	2	Head ropes.
2	Saddles.	2	Heel ropes.
4	Girths, web, short.	1	Set of combs and brushes.
2	" thong.	2	Sponges.
4	Stirrup leathers.	1	Leather.
4	" irons.	2	Cloths.
2	Cruppers. But a girth put back in front of the sheath answers better; must be looked to with a gelding or stallion, as it is apt to hinder him staling.	3	Nose bags.
		1	Set of blacking brushes.
		4	Tins " for leather.
		12	Paste blacking.
		2	Tins dubbing.

TWO BOXES OF INSTRUMENTS AND APPURTENANCES.

1.—Deal box, square, lined with zinc, hinged lid, lock, screwed down also with four screws, wooden cleats at ends, and rope handles.

No.	Article.	No.	Article.
1	Transit of azimuth instrument, in box, case, and sling.	6	Quires, Lett's, sectional and cross lined paper.
1	Theodolite, 5″, vertical and horizontal, box, case, and sling.	3	Portfolios.
1	Sextant, box, case, and sling.	3	Prismatic compasses, with slings.
1	George's horizon and mercury complete.	1	Bottle of mercury.
		2	Aneroids in cases, with slings.

2.—Box, long deal, screwed down, cleats, and rope handles.

No.	Article.	No.	Article.
2	Revolvers.	1	Marquois scales in box.
100	Ammunition.	1	Brass protractor in box.
2	Belts and pockets for revolver.	1	Stand for azimuth instrument.
1	Set theodolite (5″) legs.	1	Large lantern for candles.
1	Stand, prismatic compass.	12	Candles in box.
2	Parallel rulers, large.		

One box containing portable kitchen stove, with utensils, and supply of petroleum and wick.

(To be used when other means fail, or when the camp is stationary, or the weather is very wet and cooking under cover necessitated. Should be carried in a wooden box with supply of petroleum in strong bottles or flasks.)

Lamp ..... 1 or 2, according to stove.
Wicks ..... 1 dozen.
Petroleum ..... 1 gallon, in 4 quart flasks.

Rippingille's Patent No. 25, or hurricane stove, includes :—

	£	s.	d.
Stove kettle.....	1	3	6
Stewpan	0	4	0
Steamer	0	3	0
Fryingpan and cover	0	3	0
	1	13	6
Add { Oil..... 1/6 / Wick... 1/0 / Flasks... 3/0 }	0	5	6
	1	19	0

A few tin cups, plates, steel knives and forks, &c., can be stowed away in this box also.

Can be carried, with all appliances, in a box 1′ 9″ × 1′ 3″ × 1′ 2″.

When fuel can be had, and a fire can be made on the ground, a tripod cooking arrangement is as good as any, and is very easily set up.

Four iron bars of 1″ flat iron, 3′ long.
One round iron rod, $\frac{3}{4}$″ diameter, with staple ends 4′.
Six or seven hooks, sliding on the rod, to hang kettles on.

The iron bars are run 6″ into ground, secured and bolted with small bolts attached to one of them by a chain, through eyes in both. The round iron laid in the crutch, and the kettles suspended over the fire made on the ground.

One box of meats, stores, &c. :—

Preserved Meats and Provisions.

(Should be in a wooden box with hinged lid, to correspond to portable kitchen, and of corresponding weight, say total 50 lbs.)

	lbs.
Compressed tea, 3 lbs. ..... / " vegetables, 12 lbs.... } ...	15
Meats ..... / Soups ..... } ...	15
Cocoa	4
Coffee	6
Sugar	2
Tobacco	3
Biscuits.....	2
Knife for opening tins	$\frac{1}{2}$
	$47\frac{1}{2}$—say 50 lbs.

Can be carried in a box 1′ 9″ × 1′ 3″ × 1′ 2″, which should be fitted with D's or eyes in the top longitudinal angle formed by top and back; should be iron bound and fitted with a lock.

Whenever boxes are carried it is as well, if possible, to have the corners "bull-nosed" and the angles rounded.

This box should be carried by the same animal as the kitchener.

One box of stationery, deal, with hinges, lined with tin or zinc, top screwed down, wooden cleats, and rope handles.

No.	Article.	No.	Article.
1	Large seal, device or initials.	100	Envelopes, foolscap.
3	Sketch books in cases.	50	" note.
8	Note books.	2	W.O. Book 127.
6	Account books.	2	" 129.
6	Colors of sorts.	2	" 136.
12	Color cups or saucers.	1	Bottle ink, black.
4	" brushes, camel's-hair.	1	" red.
4	Penholders.	12	Ink powders, black.
1	Box pens, nib.	6	" red.
1	" barrel.	6	Sealing wax sticks.
50	Quill pens.	2	Pieces indiarubber.
12	Pencils, lead, various.	12	Cards, plain, 6″ × 5.
1	Box paper fasteners.	2	Screw back books.
1	Knife, desk.	2	Guard books.
1	Knife, paper.	1	Turkish vocabulary.
12	Pins, drawing.	1	German and English dictionary.
3	Pieces tape, red or green.	1	French " "
1	Ball cord silk, green.	1	Italian " "
2	Needles for do.	1	Outlines of astronomy.
2	Rulers, round.	1	Hints to travellers.
1	Brass protractor in box.	1	Handbook, Turkey, Murray.
3	Cardboard do	1	Army list.
2	Thermometers in tin case.	1	Navy "
2	Tumblers, toughened glass.	2	Kiepert's "Turkey in Europe."
2	Boxes drawing instruments.	1	Map showing boundaries as per San Stefano and Berlin.
24	Sheets paper, antiquarian.		
1	Roll varnished tracing paper.	1	Herzegovina, Bosnia, Servia, and Montenegro.
1	" linen tracing.		
6 qr.	Foolscap, plain white.	1	Austrian staff map.
3 "	" ruled white.	1	Correspondence relating to the Treaty of Berlin, maps and despatches.
6 "	" plain blue.		
3 "	" ruled blue.	1	Frome's "Surveying."
1 "	Bank post.	1	Nautical almanac.
4 "	Note.	1	Magnetic variations and map of stars.
50	Envelopes, demy.		

One box of carpenter's tools, and a few shoeing smith's requisites. Deal, bound with iron; lock, and handles at each end. Dimensions, 2′ 6″ × 9″ × 1′.

No.	Article.	No.	Article.
1	Jack plane.	2	Hammers, one with claw.
1	Smoothing plane.	2	Bradawls.
1	Short axe.	3	Gimblets, of sorts.
1	" adze.	3 lb.	Nails.
1	Pickaxe, light and good.	2 "	Screws.
3	Chisels, of sorts.	1 "	Copper wire.
2	Tiles.	1 "	Iron " fine.
2	Spokeshaves.	1	Wrench or spanner.
1	Saw.		
1	" tenon.		*Shoeing Smith.*
3	Screw augurs.		
2	" drivers.	2	Drawknives.
1 pr.	Pincers, small.	1	Hammer.
1 pr.	" large.	75	Nails.
1	Hand vice.	8	Shoes.

LIST

OF

NECESSARIES AND LUXURIES,

FOR

CAMPAIGNING AND EXPLORING,

BY

CAPT. T. FRASER, R.E.

(Reprinted by permission.)

THOSE marked **A** to accompany the Officer always. Those marked **B** to do so when convenient. Those marked **C** as a reserve, or when in a standing camp near the base. Those marked **?** are exceptional.

Luggage and Furniture.				Horse Appointments.			
No. and description.	How carried.	Approx. weight.	Approx. cost.	No. and description.	How carried.	Approx. weight.	Approx. cost.
		lbs. oz.	£ s. d.			lbs. oz.	£ s. d.
Bedstead bag ?	B (1)	2 0	0 15 0	1 regulation saddle, with thong, girth, stirrups and shoe case	A	17 8	5 16 6
Soldier's kit bag	A	1 9	0 4 9	2 wallets	A	2 0	1 12 6
Mule basket, 24ins. by 11ins. by 15ins. deep inside	B (2)	18 0	2 5 0	2 pockets	A	2 0	1 12 6
OR				3 cloak straps	A	0 8	0 3 0
Bed bag	B (1)	12 0	2 15 0	3 valise straps	A	1 0	0 3 6
				1 saddle cover	A	2 0	0 5 6
				1 spare shoe and nails	A	1 4	
Furniture.				1 double bridle and bits	A	5 0	1 2 0
				1 headstall and halter	A	2 4	0 7 3
1 air cushion	A	3 0	1 5 0	1 regtl. nosebag	A	1 3	0 5 6
1 blanket bag	A	4 8	1 5 0	1 horse blanket	A	7 0	0 13 6
1 bedstead ?	B or C	14 0	1 10 0	1 roller	A	1 0	0 4 6
1 4-legged stool (Field's)	B (2)	2 0	0 7 6	1 regtl. packsaddle		50 0	4 15 0
1 table complete	B (1)	6 0	0 14 0	1 headstall and halter			
1 pole strap ?	B	0 10	0 2 9	1 blanket	A or B		
1 bath and case	A or B	2 8	0 17 0	1 nosebag			
1 indiarubber basin	A or B	0 12	0 5 6	1 spare shoe and nails			
1 looking glass ?	B (1)	0 8	0 0 6	1 spare halter	B	0 8	0 1 5
1 sword cover, leather	B or C	0 8		2 roller bandages	B	0 8	0 2 3
1 spare blanket ?	B or C	4 8	0 8 6	1 curry comb (for 3)	B	0 8	0 0 7
1 folding chain chair ?	C (1)	5 0	0 15 6	2 brushes (for 3)	B	1 8	0 8 0
1 ground sheet ?	?	3 7	0 15 0	1 spare fore shoe	B	1 4	
				1 " hind "	B	1 4	
				Spare nails	B	0 2	
				For Camp.			
				1 indiarubber bucket	(1)	1 0	0 2 0
				1 picket shovel ?		2 8	0 2 6
				1 hand axe ?		2 0	0 2 6
				1 shoeing hammer ?		1 0	
				1 picket rope ?		8 8	0 2 6
				1 heel rope ?	B or C	1 10	
				2 canvas water bags for carrying water on a horse; each for 8 gals. (per party) ?		5 0	
				1 mallet			
		Totals. lbs. oz.				Totals. lbs. oz.	
In addition to luggage... A		7 8		All for horse	A	43 0	
B		11 4		Exclusive of pack equipage. B		6 2	
C		14 8		C		2 10	
?		11 8		?		19 0	

Clothes.

No. and description.	How carried.	Approx. weight. lbs. oz.	Approx. cost. £ s. d.
Regulation waterproof cloak and hood	A	3 12	2 8 6
1 pair riding boots	A	4 0	1 16 0
1 pair indiarubber boots	B	5 0	1 8 0
1 woollen nightcap	A	0 2	0 1 10
1 pair shooting boots	P	3 2	1 7 6
4 spare laces	A & B	0 1	0 2 0
1 pair leather gaiters	B or C	1 0	0 6 3
3 flannel shirts	1 of each A, rest B	2 4	1 10 0
3 pair drawers		1 4	0 16 6
3 silk handkerchiefs		0 3	0 9 0
5 prs. of worsted socks		1 4	0 11 0
2 pairs stockings		1 2	0 8 0
2 cholera belts		0 10	0 9 0
1 face net bag	A or B	0 0	
1 spare pair braces	B	0 2	0 3 6
1 pair hunting spurs	B	0 8	0 12 6
1 pair sleeping trousers	B	1 0	0 8 9
1 pair canvas shoes	B (6)	1 0	0 2 6
1 fur cap	P	B or C	0 6
1 cashmere neck handkerchief	P	A	0 3
2 pair woollen drawers	P	A	2 0
2 " vests	P	A	1 8
Uniform.			
1 helmet	A		P
1 forage cap	A or C		P
1 sword sling	A	0 1	0 3 0
1 sword belt	A		P
1 cross belt	P	A or C	P
2 patrol jackets	A & B	6 0	9 0 0
2 pair pantaloons	A & B	3 0	
1 pair reg. spurs	A	0 12	0 10 0
1 cloth great coat	A or C	7 8	5 5 0
1 " cape	P	A or C	
3 pairs white woollen gloves	P	A B C	0 9 0 6 0
1 pair bearskin gloves	P	A or C	0 6 0 5 0
1 tunic	P	A or C	3 2
Evening dress clothes for travellers	P		
		Totals. lbs. oz.	
Inc. waterproof	A	5 6	
	B	16 2	
	C	8 8	
	P	11 0	

Cooking Materials and Food.

No. and description.	How carried.	Approx. weight. lbs. oz.	Approx. cost. £ s. d.
1 Etna, consisting of—			
1 tin and lid	A	2 6	0 4 0
1 burner and stand			
1 ½-pint spirit bottle			
1 match box			
1 strainer (net)	(4)		
1 strap			
1 spoon and fork	A	0 2	0 3 0
2 pint tins of spirits	B & C (1)	2 5	0 6 0
1 canteen case containing—			2 0 0
1 tin kettle	B for 3	15 0	(0 1 3)
1 frying pan			
1 wire gridiron			
1 cork screw (Shafer's)			
1 salt and pepper box			(0 1 9)
1 tin opener (Lund's)			
1 Turkish coffee pot			
1 small meat knife			
1 cook's iron fork&spoon			
1 small soup ladle			
2 plates	B	2 0	
2 tin cups			
2 spoons			
2 small spoons			
2 knives			
2 forks			
1 egg cup			
Food.			
Compressed tea	A (13)	0 1	
" "	B	0 8	
" "	C	2 0	0 9 4
Coffee and milk in ½-lb. tins	A	0 8	0 0 6
" "	B	3 0	0 3 0
" "	C	4 0	0 4 0
Cocoa and milk "	B	1 8	0 1 6
" " "	C	4 8	0 4 6
Cooked corned beef in 2-lb. tins	A	0 8	0 0 7
" "	B	4 0	0 2 8
" "	C	6 0	0 4 0
Brand's extract of meat	A	0 1	0 2 3
	B	0 4	
Consolidated pea soup	A	0 3	0 0 ½
" "	B (7)	2 0	0 1
" "	C	2 0	0 1 6
Ships Biscuit	A	1 0	0 9 0
" "	B	P	
Salt, pepper, and sugar	A	0 2	
" "	B	P	
		Totals. lbs. oz.	
Inc. 2 lbs. 7 ozs. of food	A	5 0	
Inc. 11 lbs. 4 ozs. of food and 7 lbs. for canteen	B	19 6	
Inc. 18 lbs. 8 ozs. of food	C	19 11	
	!	0 0	

Stationery and Medicines, &c.				Sundries.			
No. and description.	How carried.	Approx. weight.	Approx. cost.	No. and description.	How carried.	Approx. weight.	Approx. cost.
		lbs. oz.	£ s. d.			lbs. oz.	£ s. d.
1 pair folding compasses ..	A	0 1	0 13 6	2 watches and keys	A	0 12	
1 pocket dictionary	A (5)	0 3¾		2 spare do. keys	B		
1 protractor	A	0 1	0 2 6	1 telescope	A	2 0	2 5 0
1 "perfection" penholder	A (10)	0 0¼	0 0 6	1 prismatic compass.....	A	0 9	2 4 0
2 spare " "	B	0 0½	0 1 0	1 water bottle 1¾ pints, with straps (filled)	A	2 10	0 3 6
1 note book 5½ in. by 3½ in.	A	0 4	0 1 0	1 pocket flask "	A	0 8	0 4 6
2 "	B	0 8	0 2 0	1 steel yard measure	A	0 1	0 2 0
1 pocket diary	A	0 8	0 1 0	1 pocket lamp	A (3)	0 10	0 7 0
1 map of country	A	0 2		1 collapsing cup.....	A	0 4	0 3 6
1 small writing pad	A	0 2	0 0 6	1 comb in case	A	0 1	0 0 9
Seal and wax	A	0 2		1 haversack, linen.....	A	0 9	0 0 9
1 Ransome's ink bottle ...	B	0 4	0 4 0	1 " mail cloth ?	A	1 2	0 8 6
1 packet ink papers ..... ?	B	0 1	0 0 6	1 knife (clasp)	A	0 8	
1 soldier's pocket book ...	B	1 0	0 3 5	1 revolver and case	A	2 0	2 0 0
Writing and blott. paper..	B	1 8		Cartridges for do.....	A & B	0 8	
Envelopes and pens.....	B	0 8		1 small towel	A	0 10	
				1 piece soap	A	0 1	
				1 tooth brush and cap.....	A	0 2	0 0 9
				1 pair boot hooks ..... ?	A	0 4	0 1 10
Extra for Staff, & R.E.				1 pocket filter (12) 2⅝ in. by 1¾ in.	A or B	0 8	0 5 0
				Spare tube & plug for do.	A	0 0½	0 0 4
Sketching case and cover, or sabretache.....	A			2 towels	B	2 8	
1 aneroid (3 ins.)	A	0 10		1 pair candlesticks 3 in. ?	B (8)	0 6	0 2 6
Ruled post paper	A			2 spare cloak straps.....	B	0 3	0 1 4
Indiarubber pencil	A		0 0 6	1 large tin of wax matches	B	0 4	0 1 0
Colored and common do.	A			1 ball of string	B	0 2	0 0 4
Shading stump (large) ...	A			4 small gimlets for pegs ...	B	0 4	0 1 0
3-in. colour box	B	10 0	0 7 0	1 housewife.....	B	0 4	0 5 6
Scale paper.....	B			1 holdall, with scissors, hair, tooth, clothes and nail brushes, and soap box	A or B	1 2	0 8 6
1 tin desk filled, and canvas cover.....	B or C		1 15 0	Case for two candles	A or B	0 2	0 0 4
Abney level	A or C	0 9	1 13 0	1 small sponge and bag ...	B	0 6	0 1 10
Sextant ..... ?	B	1 0	3 15 0	4 spare tooth brushes	B	0 3	0 1 8
1 roller copying press	B (9)	1 0	0 8 0	2 " nail brushes.....	B & C	0 2	0 1 0
1 bottle copying ink..... ?	B	0 5	0 3 0	3 shoe brushes (for 3)	B	1 8	0 3 9
Copying books	B		0 1 0	1 water bottle for reserve of brandy	B	2 10	0 1 2
				Soap.....	B & C	1 8	0 0 9
				Lamp candles, 12 to a lb.	B	2 0	0 2 0
				in a tin.....	C	3 0	0 3 0
Medicine.				Useful papers.....	A, B, C	1 8	0 0 8
				6 indiarubber bands.....	B	0 2	0 0 3
8 5-grs. silvered pills of quinine	A		0 2 0	6 split steel rings	B		0 0 2
Half oz. bottle of sulphate of quinine	B		0 7 6	4 tins of dubbing	B	0 8	0 1 2
2 small bottles of chlorodyne.....	A & B		0 1 7	1 spare lamp glass	B	0 2	0 0 6
1 tin mustard leaves	A or B	1 8	0 1 1	Prayerbook			
1 small bottle of rhubarb	A or B		0 0 7	Passports ..... ?			
Sticking plaster, lint, bandage, needles and thread, safety pins	A		?				
20 5-grs. pills of ipecacuanha	A & B		0 0 8				
Insect powder ..... ?	A	0 4	0 0 9				
Carbolic oil..... ?	A & B	0 6					
		Totals. lbs. oz.				Totals. lbs. oz.	
Exclusive of those for staff and R.E.	A	2 2			A	6 6	
	B	4 15			B	12 10	
	C	0 0			C	5 2	
	?	0 7			?	1 12	

REMARKS.

Almost everything in this list can be got from the Army and Navy Store, 117, Victoria Street, where arrangements are being made to keep a sample set. A few additional references are given—

(1) White, Aldershot, where also samples can be seen.
(2) Allen, the Strand.*
(3) Salsbury, 126, Long Acre.
(4) Scott, 42, Bedford Street.
(5) Intelligence Branch, War Office.
(6) The North British Rubber Co., 4 Cannon Street.
(7) Kopf, 36, Craven Street, Strand.
(8) Barron and Wilson, Strand.
(9) Mordan, 72, Cheapside, E.C.
(10) Richford, 180, Fleet Street, E.C.
(11) Lund, 24, "
(12) Silicated Carbon Filter Co., Church Road, Battersea.
(13) Compressed Tea Co., 36 Southwark Street.

Steel articles, such as scabbards, spurs, chains, &c., can be plated with Nickle at small cost: this prevents rust.

Where articles are marked to two letters with "or," their weight is assigned to the second letter.

The totals given below do not include clothes actually worn (though the numbers in the lists include those worn), nor arms, telescope, compass, and watch, which are also worn.

GENERAL TOTAL = 191 lbs., exc. of horse appts.

A = 26½ lbs., and 43 lbs. for horse appts.
B = 70½ lbs. (Including 11½ lbs. of food and 7 lbs. for canteen.)
C = 50½ lbs. (Including 18 lbs. 8 ozs. of food and 3 lbs. of candles.)
? = 43½ lbs. (Including 14 lbs. of Camp Equipment.)

* [Messrs. SILVER & Co., CORNHILL, are also strongly recommended.—H.W.L.H.]

THE EFFECT OF SHELL ON MUD WALLS.

CONTRIBUTED BY

BRIG.-GENERAL DENIS-DE-VITRE, R.A.

KANDAHAR,
16th April, 1881.

THE accompanying papers marked A, B, C, D, and E, are forwarded to the Secretary, R. A. Institution, for publication if deemed of sufficient interest.

The object of the experiments detailed in these papers was to test the destructive power of shells on mud walls; and further, if possible, to prove that shells powder filled, plugged, would explode on penetration, on which point much difference of opinion existed.

My faith in the theory has met experimentally with convincing proof of their destructive agency against such walls, and I view them as not inferior to fuzed shells for this purpose.

Unfortunately, time did not admit of more than one day's practice for each battery concerned, the breaching results could not be considered satisfactory, as in no case were they practicable; much therefore remains open to further investigation and experiment.

It must be borne in mind also, that the walls of Old Kandahar, against which the experiments were directed, are 200 years old at least, for the present city was built about the year 1747; the old city was shortly afterwards deserted, and its walls, probably never again refaced nor repaired, are now in a crumbling and ruined condition, comparing unfavourably in tenacity with the walls of recent date.

Officers commanding batteries conducted their experiments independently, and are responsible for their own statements and opinions.

W. DENIS-DE-VITRE,

Brig.-General,

Comdg. R.A., Southern Afghanistan.

A.

From Lieut.-Col. W. Carey, R.A., to the Bde.-Major R.A., Southern Afghanistan.

KANDAHAR,
15th April, 1881.

Sir—In forwarding the accompanying reports of experimental practice carried on by batteries as per margin, with my statement showing a comparison of ammunition and power expended in breaching operations against the walls of Old Kandahar, on the 5th, 6th, and 8th inst., I have further to state that the face of the wall was 30 ft. high, while in the interior of the work it only measured 20 ft.

H/1
F/2
14/9

The wall was originally faced with sun-dried bricks inside and out, and all gateways lined with the same material, otherwise the whole depth consists of made clay in layers of 12 to 18 inches.

The firing carried on by 14/9 was commenced by cutting a horizontal line a little below ½ the height of the front or face of the wall, that is 15 + 2, about 17 ft. below the top, or only 3 ft. above the interior level. On close inspection I found such was the case, unless indeed it was still lower, and at that level the wall was 28 ft. thick. The O.C. 14/9 gives the breach as 16 ft. wide, my measurement makes it only 14 ft., so that the actual lines cut were 10 ft. longer than necessary. Under these circumstances it is not surprising that the line of fire had to be continually and gradually raised, forced upwards by the accumulating debris, until the guns pierced and breached the wall 8 ft. below the top.

The "F" batteries appear to have laid their guns about 10 ft. below the top, so that time was gained to shake and nearly penetrate the wall before the falling earth caused the line of fire to be raised, and the upper portion 5 or 6 ft. of wall was then easily blown away. From inspection after the breaches were made there would have been no difficulty in cutting down 4 ft. or more of the shattered wall. In this way the field batteries with lighter guns appear to have effected an equal amount of work as the 40-prs., with a saving of one-third the weight of projectiles, bursting shell charges, and power in foot tons.

With regard to the description of fuzes used with common shell, I am of opinion that those fired with metal plugs and time fuzes bored to act at comparatively the same time are the most effective, as the whole power of the shell is thus thrown into the work, plugged shell breaking up and exploding apparently at the end of penetration. At times the effect was most marked by larger masses of earth coming away, leaving deep craters.

With regard to shell bursting, as far as I could judge by eye and ear, it was in the following order fuzed with—

1st. Percussion fuze.
2nd. Time fuze, 2/10, 3/10, 4/10, 5/10th.
3rd. Shell with metal plugs, or 7/10th time fuze.

Unbored fuzes did not appear to delay the action more than the

metal plug. I am unable to affirm this order, it can only be proved by careful practice and well planned arrangements, the necessary means for which are not available in this country.

From the above it also appeared to me that the explosion of plugged shell was due to the act of breaking up when the base portion (in which is stored all the driving force) ground upon the head and broken sides firing the bursting charge by friction, which latter had probably become more sensitive by heat generated by the shell's passage through the air, and by the act of striking and penetrating the wall.

Each of the three batteries report that portions of loaded shell, fuzed and not fuzed, were blown out of the work burning as if loaded with fuze composition. No doubt this arose from the shell powder having become mealed and compressed. In proof of this I picked up a portion of a shell (base part) with the bursting charge in that state, and in which was embedded a portion of the wood of the time fuze with powder in the powder channel and a portion of the fuze composition, showing that the shell had broken on penetration, but no explosion had occurred owing to the damaged nature of the bursting charge. After keeping this for two or three days I fired portions, scraped out, with a lighted stick.

I have the honor to be,

Sir,

Your most obedt. humble servt.,

WM. CAREY, Lt.-Col. R.A.,

Comdg. R.A., Kandahar.

B.

Table giving the Results of Breaching Practice carried out by the Royal Artillery against the Walls of Old Kandahar, in April, 1881.

Commanding Officer.	Bde. and Batt.	Nature of gun.	Dimensions of breach.								Time occupied in hours.
			As measured by battery.			Earth cut away.	As measured by Lt.-Col. Carey.			Earth cut away.	
			Width.	Height	Thickness.		Width.	Height	Thickness of wall.		
			ft.	ft.	ft.	c. ft.	ft.	ft.	ft.	c. ft.	
Major Crosthwaite ...	H/1	9pr.RML	15¾	6½	10	1023½	12	6	11	792	3½
Capt. W. O. Smith...	F/2	9pr.RML	14	5	11	770	14	5	11	770	4
Major G. A. Crawford	14/9	40prRBL	16	7	10	1120	14	8	10	1120	1⅓

		Weight.		No. of rnds. fired.	Total weight fired.	Bursting charges.		Velocity.		Energy in ft. tons.		
		Proj.	Chg.			per shell.	Total.	Muzzle.	400 yds.	Muzzle.	400 yds. from gun.	Total striking
		lb.	lb.				lb.	f.s.	f.s.			
Major Crosthwaite ...	H/1	9	1¾	136	1224	7½ oz.	63¾	1380	1145	118	81·82	11127½
Capt. W. O. Smith...	F/2	9	1¾	129	1161	7½ oz.	60	1380	1145	118	81·82	10554¾
Major G. A. Crawford	14/9	40	5	84	3360	2¼ lbs.	189	1180	1087	386	327·73	27529¼

C.

Report of Experimental Practice carried on at the Walls of Old Kandahar by "H" Battery, 1st Brigade, Royal Artillery, on the 8th April, 1881, by orders of Brig.-General Denis-de-Vitre, Commanding Artillery, S. A. F. Force.

Range.	No. of rounds.	Plugged shell.			Percussion fuze.	Fuzed shell. Time fuze.			Shell filled with sand.		Remarks.
		Burst.	Doubtful.	Blind.		2″	3″	4″	Broken up.	Not broken up.	
yds. 395	6	—	—	—	—	—	—	—	6	—	These shell penetrated to an average depth of 3 ft., width of crater 4 ins.; they all broke up.
〃	30	24	2	4	—	—	—	—	—	—	Plugged shell penetrated at the beginning 2 ft., and then burst, causing a crater of 9 to 12 ins., the six rounds from 13 to 18 penetrated 8 ft., with a crater of 3 ft.; the next six rounds penetrated 4 ft., with a crater 1 ft.; the next six rounds penetrated 4 ft., with a crater of 2 ft.; the last six rounds penetrated too deep for measurement, the crater formed was 8 ft. from top of the wall; large part of lower wall knocked away; safety-pin withdrawn.
〃	4	—	—	—	4	—	—	—	—	—	
〃	2	—	—	—	2	—	—	—	—	—	Safety-pin not withdrawn, crater too deep for measurement.
〃	6	—	—	—	6	—	—	—	—	—	Safety-pin not withdrawn, penetration too deep for measurement. Salvo.
〃	6	—	—	—	6	—	—	—	—	—	Safety-pin not withdrawn, top piece of wall fallen in. Salvo.
〃	6	—	—	—	6	—	—	—	—	—	Safety-pin not withdrawn, penetration 8 ft., diameter of crater about 2 ft.
〃	7	—	—	—	—	7	—	—	—	—	1st and 2nd of these rounds caused a crater 30″ × 6″.
〃	1	—	—	—	—	—	1	—	—	—	No apparent result.
〃	4	—	—	—	—	—	—	4	—	—	Salvo. Earth from top fell in.
〃	6	—	—	—	—	—	—	6	—	—	Wall not specially observed. Salvo.
〃	6	—	—	—	—	—	—	6	—	—	Salvo. Large quantities of top wall fell away; breaching commenced higher up.
〃	6	—	—	—	—	—	—	6	—	—	Salvo. Quantity of earth fell from front, and some from rear of the wall.
〃	6	—	—	—	—	—	6	—	—	—	Salvo. Wall pierced.
〃	6	—	—	—	—	—	6	—	—	—	Salvo. One shell went through and burst beyond the wall.
〃	6	—	—	—	—	—	6	—	—	—	Salvo. Earth fell in masses on near side of wall.
〃	6	—	—	—	—	—	6	—	—	—	Salvo. Three more shell went through the wall blind.
〃	6	—	—	—	—	—	6	—	—	—	The 115th round went through blind, the 118th went through forming a large breach.
〃	6	—	—	—	—	—	6	—	—	—	Salvo. Breach enlarged, one shell went through and burst.
〃	6	—	—	—	—	—	6	—	—	—	Breach very much enlarged, and earth cleared away on right of breach.
〃	4	—	—	—	—	—	4	—	—	—	Breach cut away on left, measurement of breach, width 15′ 9″, height 6′ 6″.
	136	24	2	4	24	7	47	22	6	0	

Wall of clay, of very adhesive nature. 20 ft. high in rear or interior of the work; the front varying in height up to 30 ft., owing to the irregular nature of the ground, which apparently had not been levelled at any time, with a thickness at base of 24 ft., varying up to 10 ft. thick at top of wall.

The whole of the shell filled with sand broke up, and so did the plugged shell filled with powder, as far as could be ascertained; in some of the latter, however, the bursting charge did not ignite, and on examining them it was found that the bursting charge had caked into a hard mass, although it was in perfectly good order before firing. I tried both percussion fuzes with the safety-pin withdrawn and with the safety-pin left in, and for breaching purposes in mud walls I prefer the latter, as the fuze appeared to me to be too sensitive in the former case. Not a single shell with the safety-pin left in failed to burst, and the effect of salvos with these shell was very great. I am of opinion that the wall should be first prepared by firing single shells, fuzed either with percussion fuze with safety-pin left in, or time fuzes bored long, until it has been well undermined, and after that the effect of salvos in bringing down large masses will probably be very great.

In these operations no fuzed shell failed to burst; one shell, time-fuzed, burst at the muzzle. I consider that of the shell fuzed with time fuze those bored 3/10 produced the best effect, those bored at 2/10 seemed to burst on impact, whilst those bored 4/10 had the action delayed, but did not bring down so much debris as the others.

C. CROSTHWAITE,

Major R.A.,

Comdg. "H" 1st Bde. R.A.

D.

Report on Experimental Practice carried on at the Walls of Old Kandahar, by F/2 R.A., on the 6th April, 1881, under orders of Brig.-General De-Vitre, R.H.A., Comdg. R.A., S. Afghanistan.

The wall was built of sun-dried bricks and clay; its height was about 18 ft. It was 24 ft. thick at the bottom, diminishing to 15 ft. about 5 ft. up, and tapering to 11 ft. at the top. Range 395 yds. Elevation 26′.

Com. shell, filled with sand.	Common shell. Metal plugs. Burst.	Blind.	Doubtful.	Com. shell. Percussion fuze.	Common shell and time fuzes. Nine seconds. $1\frac{3}{10}$	$1\frac{5}{10}$	Unbored.	Five seconds. $\frac{7}{10}$	Unbored.	Total shell fired.	Remarks.
3	—	—	—	—	—	—	—	—	—	3	
—	12	2	1	—	—	—	—	—	—	15	
—	—	—	—	12	—	—	—	—	—	12	
—	—	—	—	—	6	—	—	—	—	6	
—	—	—	—	—	—	6	—	—	—	6	One burst at muzzle, Mark II., 4/75.
—	—	—	—	—	—	—	—	6	—	6	
—	—	—	—	—	—	—	6	—	—	6	
—	—	—	—	—	—	—	—	—	6	6	One burst at muzzle, Mark III., 11/76.
—	—	—	—	12	—	—	—	—	—	12	Two salvos.
—	—	—	—	—	—	—	6	—	—	6	Salvo.
—	—	—	—	6	—	—	—	—	—	6	Salvo.
—	—	—	—	—	—	—	6	—	—	6	Salvo.
—	—	—	—	—	—	—	6	—	—	6	Salvo. Breach made.
—	—	—	—	—	—	—	4	—	2	6	
—	—	—	—	6	—	—	—	—	—	6	
—	—	—	—	—	—	—	—	—	6	6	
—	—	—	—	—	—	—	—	—	6	6	
—	6	—	—	—	—	—	—	—	—	6	
—	—	—	—	4	—	—	—	—	4	4	
3	18	2	1	40	6	6	28	6	20	130	

Plugged shell not as effective apparently as fuzed shell. Action of shell with time fuzes was varied; some appeared to burst on impact, with others the action was delayed; the latter was most effective. The chances of delayed action appeared to be greater when the fuze was unbored.

Percussion fuzes were apparently the most effective for the work required.

Steady firing from flank to flank gave better results than salvos.

Shell filled with sand had little or no effect, the penetration was from 17 to 30 inches.

Breaching operations were begun about half-way up the wall, the height was slightly raised afterwards, owing to accumulated debris.

Daylight was seen after a salvo constituting the 88th and 93rd round. The 102nd round completed the breach, but it was not practicable for infantry. After the conclusion of the practice the breach was 14 ft. wide, by 5 ft. deep. 20 to 30 rounds would have made the breach practicable.

(Copy signed) W. O. SMITH,
Capt. R.A.,
Comdg. F/2, R.A.

KANDAHAR,
13th April, 1881.

E

Extract from Report of Experimental Practice carried on by Major Crawford, 14/9 R.A., at the Walls of Old Kandahar, on the 5th April, 1881, under order of Brig.-General De-Vitre, Comdg. R.A., S. Afghanistan.

Wall of Old Kandahar of homogeneous clay, the face of the wall being about 30 ft. high, but varying with the nature of the ground, which was very irregular. In the interior of the work the height was 20 ft. The thickness at base was 24 ft., reducing to 16 ft., and then tapering to 10 ft. at the top.

Common shell.		Common shell fuzed.		Remarks.
Filled with sand.	Loaded and metal plugged.	Time 9″ bored long.	Percussion.	
8	—	—	—	Penetration varied from 3 to 5 ft., mean 3 ft. 8 ins., none were dug out, one was found broken.
—	8	—	—	Six reported as having exploded, but the other two were not dug out or examined.
—	—	8	—	One exploded prematurely, others on impact.
—	—	—	8	All exploded, but plugged shell appeared to burst as soon.
8	8	8	8	
Breaching Experiment.				
—	—	—	4	
—	44	—	—	Single shell.
—	28	—	—	Salvos of four shell.
—	8	—	—	
—	80	—	4	

A horizontal line 24 ft. long was cut a little below half the height of the wall. 30 single shell were expended on this, the guns being laid so as to allow the projectile to strike 1 ft. 8 ins. apart. Vertical lines 2 ft. high were then cut upwards from the extremities, and the tops joined by a second horizontal line, and the fire of the battery was kept on that rectangle and above it in salvos of four guns. At the 76th round daylight showed about 7 ft. from the top. Single rounds were then fired. At the 81st round the top of the parapet fell in, and at the 84th the breach was practicable. Had the guns in the first instance been aimed lower it would have been better. The time occupied in forming this breach was $1\frac{3}{4}$ hours.

Two loaded plugged shell, not broken, but with damaged heads, were found at the foot of the breach.

(Signed) G. A. CRAWFORD,
Comdg. 14/9 R.A.

REMARKS ON THE

WELDON RANGE FINDER,

BY

LIEUT. A. H. RUSSELL, U.S.A.,

Under the direction of Col. T. T. S. Laidley, American Ordnance Department.

(REPRINTED BY PERMISSION.)

A prism instrument made in London in the manner described by Major Richardson, R.A., accompanied his paper on the Weldon Range Finder. It will be referred to hereafter as prism No. 1.

This instrument, when tested, would not give the required reflection of 88° 34′ 3″, but gave a variable angle greater than 90°, showing that its construction was faulty, and the description given in the above paper incomplete. The theory and use of the instrument are, however, correctly given.

Another prism was, therefore, prepared, differing from prism No. 1 in the following particulars :—

While No. 1 was so constructed that the two base angles were equal, as shown in Fig. 4, (A B C=A C B,) No. 2 was required to have one

FIG. 4.

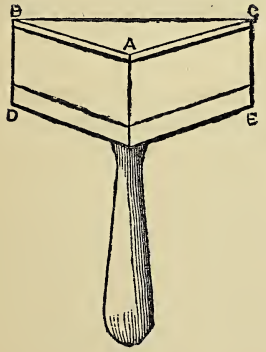
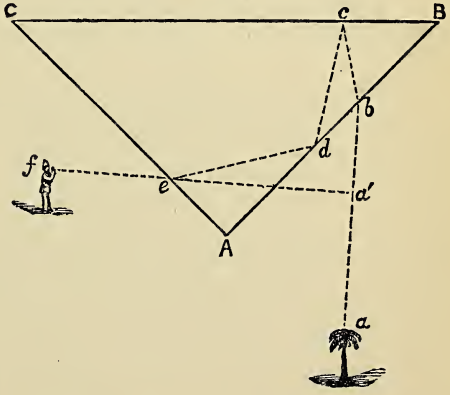


FIG. 7.



of these angles equal to one-half the third angle; or A B C=$\frac{1}{2}$B A C.

The course of light in the prism is indicated in Fig. 7, which shows

a horizontal section of the prism. The light from the object at *a* enters at the surface A B; is then refracted more nearly normal to this surface; is then reflected internally from the silvered surface B C, and again internally from the unsilvered surface A B; passing out through the surface A C, where it is again refracted, but away from the normal; and reaching the eye of the observer at *f*. The angle *f a' b*, between *f e* prolonged and *a b*, is the deviation of the light, or the angle reflected by the prism.

It is evident that the deviation would be the same if the observer and the object changed places, the course of the ray passing from *f* to *a* along the broken line *a b c d e f* instead of from *a* to *f*.

The reason for making the angle B one-half the angle A appears from the following discussion :—

After the light enters the prism the two surfaces A B and B C act as mirrors, and, from the well-known principle that light reflected twice from a combination of two plane mirrors undergoes a deviation equal to twice the angle of the mirrors, the angle made by *d e* with *c b* is twice the angle B. In order now that this deviation shall not be changed by refraction in passing through the surfaces A B and A C, the rays *b c* and *d e* should make equal angles with the latter surfaces—that is, B *b c* should be equal to A *e d*. The refraction will then be the same at both surfaces.

The following relations subsist among the angles in Fig. 7 :—

B *c b*=180°—B—B *b c*=C *c d*,
B *d c*=C *c d*—B=180°—2 B—B *b c*=A *d e*,
A=180°—A *e d*—A *d e*=180°—A *e d*—(180°—2 B—B *b c*).

Now, since A *e d* must be equal to B *b c*, A must be made equal to 2 B in order to obtain an invariable deviation equal to A.

To give a deviation of 90°, A should be 90°; B and C each 45°. In this form it can be used as a *camera-lucida*.

For a deviation of 88° 34′ 3″, A should be 88° 34′ 3″, and B 44° 17′ 1″·5. In this case C, not being equal to B, the angle B should alone be used for determining the deviation.

In prism No. 1, A is less than 90°, and B, which is equal to C, is greater than 45°. The deviation will therefore be variable and greater than 90°.

These results are confirmed by observation.

It is evident that the deviation given by the prism is chiefly dependent upon the angle B, because a slight error in B produces twice that change in the deviation; a slight error in A affects the deviation only by a slight difference in refraction at the two surfaces, and though the deviation will not be invariable it will change but slightly. This is illustrated with prism No. 2, in which B is not exactly one-half A. It requires, also, the multiplier 18·3 instead of 20. The table appended shows, however, that very good results can be obtained with it as it is, and doubtless less variation would occur in the measurements were the prism accurately ground. Accurate grinding was found to be difficult with the instruments at command, but the defect can be readily supplied if more prisms are required.

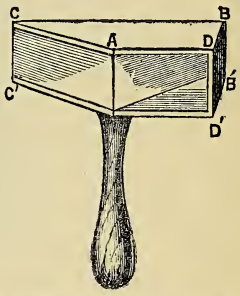
The cost of prism No. 2 was $12, but Mr. Alvan Clark, who made

it, estimates that a number could be made correctly for about $2 apiece, as several could be ground together.

It is altogether probable that the true Weldon prism is similar to prism No. 2, and that prism No. 1 was made from the imperfect description given in Major Richardson's paper, where no allusion is made to the size of angles B and C.

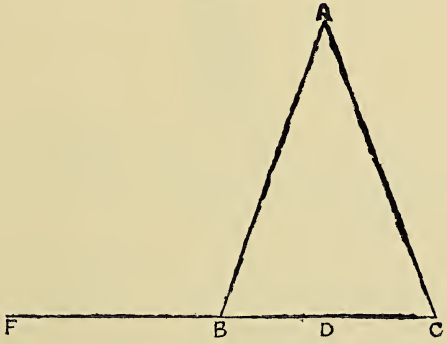
Fig. 8 shows a modification of the frame of the prism found convenient in practice. A metal screen, B D D′ B′, perpendicular to the back, projects at the side next the angle B, and this serves to cut off annoying reflections, while it prevents the use of the wrong angle in observing. To obtain the reflection of an object on the observer's right he looks into the face A C C′ A′ in a direction nearly parallel to C B, and for an object on his left he looks into the face A B B′ A′ in a direction nearly parallel to D B. If the prism is ever moved from its frame, care must be taken to replace the smallest angle next the screen.

Fig. 8.



A serious difficulty arises in using the instrument when the ground is not very open, as it is then often impossible to see, from both ends of the required base, the object whose distance is desired. This difficulty would be likely to arise to some degree with most range-finders dependent on angular measurements, unless, as in the Berdan telemeter, the base were very short. The trouble could be considerably reduced by using in connection with the Weldon range-finder a prism made to reflect an angle of 90°, such as that described above. One observer having fixed the point C (Fig. 3) with the Weldon instrument,

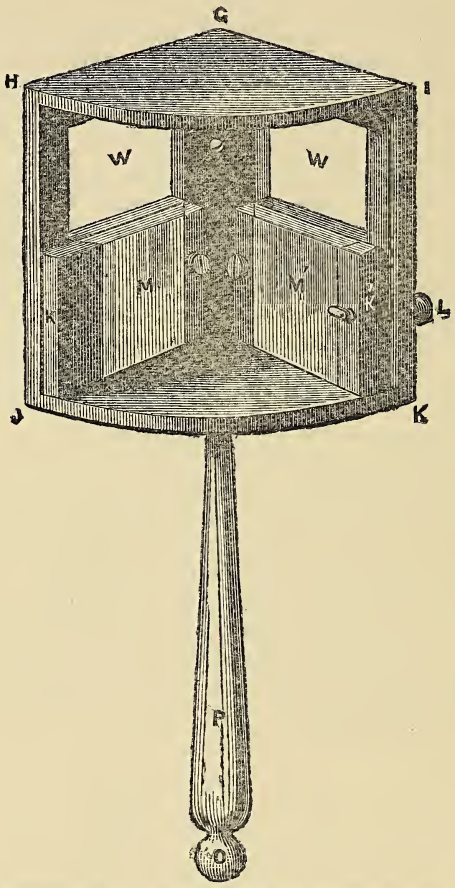
Fig. 3.



another observer with the right-angled prism moves along the line C D F until he sees A reflected from the direction C. He will then be at D, midway between C and B, and in this way an obstacle to the view from B might be avoided. The new base being half the usual one, the multiplier would have to be twice that required for the Weldon instrument alone, aud the error of observation would be somewhat increased. The right-angled prism and the Weldon prism might be fixed back to back on the same frame, so that each observer should have both at command. No screen would be needed for the right-angled prism.

Major Richardson's description of the instrument shown in Fig. 6,

Fig. 6.



is also evidently incorrect. Instead of an inclination of 88° 34′ 3″ for the mirrors, it should be half that, or 44° 17′ 1″·5, to give a deviation of 88° 34′ 3″. The angle H G I need be only about 45° instead of a little over 89°.

Fig. 9.

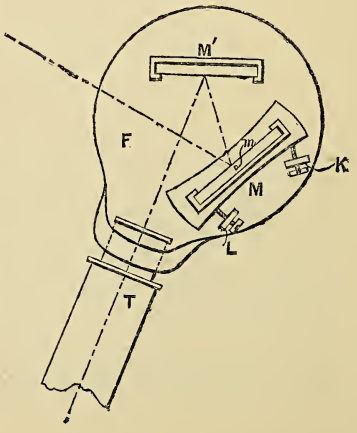


Fig. 9 shows, in plan, a proposed instrument, in which the mirrors can be adjusted at will for an angle of 44° 17′ 1″·5 or of 45°, so as to give a deviation of 88° 34′ 3″ or of 90°. This is for use in place of the two prisms described above. It is partly suggested by the Watkins (see Ord. Note 116) and partly by the Weldon range-finder. It is simpler than the former and not so limited in use as the latter since it permits the employment of two lengths of base.

The mirrors M and M′ are attached to the frame F, M being arranged to turn on the pivot at *m*. The adjusting-screws K and L limit the motion, L being set to give an inclination of 45°, and K of 44° 17′ 1″·5. It can be used either with or without the telescope T, indicated in the figure, and it is evident that a telescope could also be applied to the prism-instrument if desired. The form shown in Fig. 6 could be retained and the mirror M arranged to move between limits fixed by adjusting-screws, as described for Fig. 9.

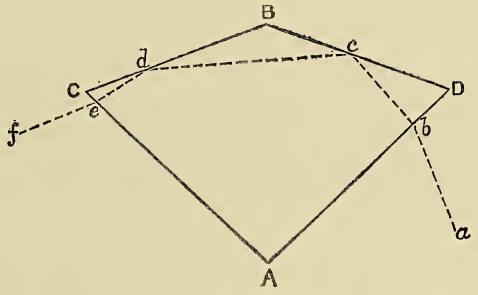
No experiments were made to time the observations, but measurements were made very rapidly with the single instrument. Two observers working together would greatly hasten the operation and probably obtain a measurement in two or three minutes. The results given in the table were obtained by a single observer.

The measuring twine and reel mentioned in Major Richardson's paper were not used, an ordinary tape measure being employed.

In using either of the instruments care must be taken to keep the reflecting surfaces vertical, and some little variation is likely to arise when the observer is much above or below the object sighted on. The faint reflection from the surfaces of the prism is of some assistance in determining when the instrument is erect.

Another form of prism is suggested by the Wollaston prism used in the camera-lucida, of which a section is shown in Fig. 10, A being

Fig. 10.



90° and B 135°; light passing along the broken line *a b c d e f* is deflected 90°. For any other angle of deflection, A should be made equal to this required angle and B should be $180° - \frac{A}{2}$. For a deviation of 88° 34′ 3″, A should be 88° 34′ 3″, and B 135° 42′ 58″·5.

Thanks are due to Professors Cross and Henck and to Mr. Holman, of the Institute of Technology; to Mr. J. Rayner Edmands, of the Cambridge Harvard College Observatory; and to Professor Cooke and Mr. Melville, of Harvard College, for the use of instruments and for valuable measurements.

Conclusions.

For open ground the Weldon range-finder would be very useful, and for general use, particularly if made adjustable to two lengths of base,

it is probably as good as any instrument combining such advantages of compactness and simplicity. It might be found useful in the hands of officers in the field, particularly on the plains.

Table of results with prism No. 2.

But one instrument was used. It was mounted as in Fig. 8.

Distance.	By Range-Finder.		Error of Observation.	
	First Trial.	Second Trial.	First Trial.	Second Trial.
Yards. 379	Yards. 382	Yards. 378	Yards. +3	Yards. −1
473	470	469·7	−3	−3·3
663	687	656	+24	−7
796	800	811	+4	+15
840	819	855	−21	+15
890	954	854	+64	−36
1289	1308	1302	+19	+13
1877	*1982	1867	*+105	−10
2045	†2092	2043	†+47	−2
2100	*2056	2104	*−44	+4
2248	2306	2324	+58	+76

* Uncertain. † Measurement of base uncertain.

Some of the above irregularities probably arose from not keeping the instrument erect.

EXTRACTS

FROM THE

"RUSSIAN ARTILLERY JOURNAL,"

NOVEMBER, 1880,

TRANSLATED BY

LIEUT. J. M. GRIERSON, R.A.

RUSSIA.—New Rules for Competitive Practice.

The range is to be 300 *sagenes* (a *sagene*, = seven feet), instead of an unknown distance between 450 and 650 *sagenes*, as formerly. In the centre of the target is to be painted a bull's-eye 20 inches in diameter, surrounded by 6 concentric circles, each increasing in radius by 10 inches. Five rounds of plugged shell are allowed to each competitor, the first being a trial shot. A hit within the bull's-eye counts 7, one within each of the above circles from 6 to 1 according to its distance from the centre. No limit of time seems to be laid down, nor is shrapnel fired. The above regulations are almost identical with those in use in the German Army.

HOLLAND.—New 7·5^{cm} (3-in.) Gun.

In 1879, Krupp turned out for the Dutch Government a new gun of the above calibre, destined for East Indian service. This gun differs from his other 7·5^{cm} pieces by its greater lightness and its efficacy, which does not yield to that of any other gun in Europe firing the same weight of projectile. The following data will serve to compare it with the Austrian 7·5^{cm} gun:—

		7·5^{cm} Gun.		
		Dutch.		Austrian.
Weight of shell	kilog.	4·3	...	4·3
Initial velocity	metr.	420	...	422
Weight of gun	kilog.	235	...	299
Weight of gun and carriage, fully packed	"	515	...	766
Weight of gun, carriage, and limber, fully packed	"	975	...	1533
Number of horses		4	...	4
Weight per horse	"	244	...	259*
Number of rounds in limber		27	...	40

Practice with Krupp's Screw Mountain Gun.

Trials have lately been carried on at Meppen with forged iron shrapnel from Krupp's new screw 6·5^{cm} (2·6-in.) mountain gun. The targets were three in number, 2·7 mètres high, and 30 mètres long, placed 15 mètres behind one another. Each target was divided

---

* This is the figure given in the "*Journal*."

vertically into 50 spaces, each 60^{cm} broad, and on each were drawn three horizontal lines at ·9 mètre (height of a man kneeling), 1·8 mètres (height of a man standing), and 2·7 mètres (height of a man mounted), from the ground. The following are the data of the shrapnel fired :— length in calibres, 3·4; weight of filled shrapnel, 4·1 kilogr.; weight of powder (service) charge, 4 kilogr.; weight of bursting-charge, ·035 kilogr. of rifle powder.

Ten rounds were fired under the following conditions :—Range, 1000 mètres; fuze set at 24 "divisions," so as to burst the shell 31 mètres short and 3 above plane. The results of the first shell are shown in the following table :—

Target.		No. of hits penetrating target.	No. of hits not penetrating target.	Total.	No. of vertical spaces struck.
1st Target	1st Horizontal Band (Lowest.) ...	29	2	68	13
	2nd Horizontal Band (Middle.) ...	17	2		
	3rd Horizontal Band (Upper.) ...	17	1		
2nd Target	1st Horizontal Band ...	18	0	60	21
	2nd " " ...	22	5		
	3rd " " ...	15	0		
3rd Target	1st " " ...	10	1	32	21
	2nd " " ...	11	0		
	3rd " " ...	8	2		
Totals		147	13	160	55

The following were the results of the other nine rounds :—

Target.		No. of hits penetrating target.	No. of hits not penetrating target.	Total.	No. of vertical spaces struck.
1st Target	1st Horizontal Band ...	127	9	358	169
	2nd " " ...	104	8		
	3rd " " ...	103	7		
2nd Target	1st " " ...	93	8	329	170
	2nd " " ...	88	28		
	3rd " " ...	95	17		
3rd Target	1st " " ...	61	21	255	172
	2nd " " ...	70	20		
	3rd " " ...	63	20		
Totals		804	138	942	511

Average number of hits per round, 104; average number of vertical spaces struck, 56.

The shells were provided with Krupp's "Distance Fuzes," which acted remarkably well.

TACTICS OF THE THREE ARMS.*

BY

CAPT. T. J. ROCH, R.A.

THERE is so much in this volume that will commend itself to the respect of all who delight in exact reasoning, that I think it will be welcomed by the great majority of those of my brother officers into whose hands it may happen to fall.

There often appears a disposition to treat the science of Tactics as one for which, as exact hard and fast rules are impossible, it is best not to attempt exact reasoning at all. With this view M. Mazel is at direct variance. He attacks each branch of his subject *ab initio*; and—where mathematics offer their aid towards the solution of any problem—he does not scruple to invoke their assistance.

In the following brief notice it is impossible to do more than point out the principal features of a book which only requires to be read to be appreciated.

M. Mazel is unable to resist the temptation of wandering at the commencement into a totally useless dissertation on Tactics in the abstract. In the course of a few pages he contrives to complicate the simple question, "What are Tactics?" by an endless number of definitions and subdivisions, which are many of them weak, and all of them irritating. In like manner, the question of how far a discussion involving Tactics may go, without infringing on discipline, is one which would possibly be interesting to the Editor of the *XIXth Century*, but scarcely to our readers, who will no doubt be glad when at Chapter II., the real subject of the book is at length reached.

The salient feature of the book is that the modern order of battle must be a far more extended one than is laid down in the French regulations on the subject.

I make no apology for taking the three arms in the same order of precedence as does M. Mazel, viz., Infantry, Artillery, Cavalry. If our readers are inclined to object to the place assigned to their own branch, I must refer them to our author for an explanation.

Starting then with the Infantry, as being the arm upon which depends the extent of front occupied by an army, M. Mazel adopts an entirely original method of treatment in dealing with the subject. His object is to so dispose of his men, that at the critical period of an Infantry engagement—whether attack or defence—every rifle shall be in use, and every man shall have room to use his rifle freely.

The first point then to determine, is how many rifles will there be

---

* La Tactique des trois Armes, par G. Mazel.

at this critical moment—that is to say, when the attack has been thoroughly prepared and the skirmishing line has crept up to assaulting distance, and is pouring in its utmost fire in those few deadly moments that precede the actual assault.

Taking a battalion at a strength of 1,000, M. Mazel calculates on a parade of 800 effectives on service, and makes this his basis.

From an extensive average of numerous battles, he finds that, in the fighting line, the troops actually engaged *may* lose as many as 25 per cent. of their number during an attack. Taking this, therefore, as possibly the case, our 800 rifles would be reduced to 600 at the crisis; and 600 is therefore the number on which M. Mazel reckons, and for which he has to provide.

Now, the question is, how to dispose of them?

By the help of an ingenious calculation, he gathers that the intervals from rifle to rifle should be $1\frac{1}{2}$ yards as a maximum, and $\frac{1}{2}$ yard as a minimum.

(As he always adopts round numbers in *mètres* I have done the same in yards).

The mean of the above gives 540 yds. as the front of a battalion. (Which, compared with our own regulations, is a very extensive front—the latter being laid down at 300 yds.)

The front would be occupied in a very similar manner to that prescribed by our "Field Exercise," so I do not propose to discuss it at length. The front of a battalion being given, that for a division or corps follows directly. The only thing left to determine being the number of battalions in first line.

With regard to this M. Mazel is again conspicuous by his aversion to depth. He is of opinion that having placed a battalion in first line on a front of 540 yds., there should be behind this a second line *only*. No third line. A general reserve he will allow to *every* body as a whole, but not a reserve to each component part. What he says, is, that if an army sets aside one or two corps as reserve, and each Corps Commander sets aside a division, and each Division Leader a regiment, there is no end to it, and these latter reserves become, in effect, third, and even fourth lines, of which the mischief is, that if the side, on which they are, is successful, they are useless—if beaten, probably more useless still, because the defeat will be due to an envelopment of both wings.

Thus, then, allowing only a second line, whose duty is to fill up gaps in the first, its strength requisite for this purpose should be in the proportion of 1 to 2 of the front line. The regiment (French establishment) consisting of three battalions, we have a front for it of $540 \times 2 = 1080$ yds., that is to say, it has two battalions in first line, and one in second line.

Having, then, any body of which to determine the front, the first thing is to settle the reserve, and then to divide the remainder of the battalions in the proportion of 1 to 2, and multiply the latter number by 540 for the front in yards.

For example, a French Corps consists of eight regiments of the Line and one battalion of Chasseurs.

Let the general reserve be two regiments and the Chasseurs, this leaves six regiments for first and second lines, or a front of 6,480 yds.

The limit laid down by French regulations is 2,250 yds. It is the object of the author to prove that reason is on his side, and that the front of 2,250 yds. is ridiculously small. The author's limit gives 4·63 men per yard.

In an army of three Corps (of which one is in reserve) the front given by M. Mazel gives seven men per yard, which is a limit that he believes it is most unwise, if not unsafe, to exceed. (Speaking from memory, I believe Mac Mahon had 7½ per yard at Wörth, and Bazaine 8 at Gravelotte). M. Mazel then instances several of the battles of 1870 in support of his theory. His arguments are always fair, and never over-strained. This part of his work is well worthy of attentive reading.

He draws the conclusion that in future it will be found that frontal attacks are so costly and difficult that envelopment will be the only practicable method that can meet with success.

Coming now to the question of Artillery, M. Mazel is entirely opposed, as might be expected of him, to the practice of crowding guns. He looks upon a closely concentrated battery as a regular shell-trap, and considers that the limit to the front of a battery should be determined by the power of the human voice—that is to say, the extent to which the Officer Commandng can make himself heard. This he takes to be 150 yds., or 30 yds. between the guns.

Now, in the matter of the number of guns, our author working out the question, as is his wont, from the beginning, says that the real limit is the number that can be put in line. He objects entirely to the system of "so many guns per thousand," which is the usual method of computation.

He says that the place for guns is on the crests, while that of Infantry in first line is either half way down the slope or at the foot of the latter, so that the guns can never get in the way of the Infantry. He is also of opinion that if guns are not to be trusted to fire over the heads of the Infantry, the sooner some new shells and fuzes are introduced the better. He therefore works out the number of guns for a Corps to be 20 batteries, and the distribution to be as follows, viz.:—

1. Corps Artillery.	2. Army Artillery.

It will be seen that he abolishes divisional artillery. The reasons being that Artillery should be under one head and direction, that the Divisional General has quite enough to do to dispose of his Infantry, without having also the Artillery to look after, and that for purposes of administration, matters would be very much simplified.

The Army Artillery would be heavy guns of position, only brought up for special purposes, either of attack or defence, and being at other times left at the base or some intermediate place.

I think most Artillerymen will cordially endorse a great deal which they will find in this book as regards their own arm. The author is

certainly very favorably disposed towards it, and highly appreciative of its value.

Now as to the Cavalry. The days of charges are numbered, and henceforth their *rôle* is to be the no less glorious and exciting one of "exploring," to use the French name for it, for which we have at present no equivalent.

As before, M. Mazel goes to the root of the matter and determines the number of Cavalry required by the following method:—

He determines the front which an Army of four Corps should occupy on the march to be a mean of 24 *kilomètres*. One Corps being allotted to each road, and one following in reserve. For he finds that on the average throughout France there is a good road at intervals of every 12 *kilomètres*. He also determines mathematically that the distance of the cavalry screen from the front of the Army should be 36 *kilomètres*.

Here, then, are bases enough to determine the necessary quantity of Cavalry for the performance of the duty of covering the front and flanks, provided we know how many to allot to each road.

Our author allows one regiment to each road, and one in reserve to every two in front, or a Brigade of three regiments to every two roads, each regiment consisting of four squadrons.

The above gives for an army of 4 Corps a force of Cavalry of six and a half (say seven) Brigades of three regiments each.

He abolishes Divisional Cavalry entirely as being now-a-days out of place, for, he argues, if with the Division they are no use to the exploring Cavalry, and if with the latter of no use to their Division.

In their place he would put a few troopers, attached as orderlies, to every Commanding Officer. This service could be performed by rotation of squadrons week about, as it would not offer many attractions.

He gives us an excellent illustration of how the duty of reconnoitring is to be performed, which is made very plain by the aid of sketches.

In Chapter V., we have the "Three Arms combined" to deal with. A battle is here, so to speak, dissected, and, unfortunately, a battle is not to be dissected beforehand. Nevertheless, it is always instructive and interesting to study an ideal which we may approximate to, even if to attain it is impossible.

Similarly, in the last chapter—called the application of the previous ones—our author has worked out with much skill and patience an imaginary campaign wherein Sèdan is avenged and the Prussian overthrown.

Like its predecessor, this chapter is very highly interesting; though perhaps a hostile critic might suggest that it is easy to fight a battle when one has the arrangements of both sides to make.

In conclusion, then, I venture to hope that these few remarks may lead many of my brother officers to look through this volume. It is full of novelty. It is entirely free from prejudice. If a thing is not capable of proof it is worth nothing to the author, and, however much one may disagree with his conclusions, it is impossible to deny that his process of reasoning is sound and logical.

I feel sure that whoever takes up this book will not put it down without having derived great pleasure from its perusal.

EXTRACTS

FROM THE

"GIORNALE DI ARTIGLIERIA E GENIO."

January, 1881.

(Résumé of the Report of a Conference, held in Vienna, by the Wissentschaftlichen Vereine, on the best method of employing Horse Artillery in the present day.)

BY

CAPTAIN A. E. TURNER, R. H. A.

The enormous increase of power gained by fire-arms in the last few years has necessarily caused considerable modifications in the tactical action of the troops of all arms. With regard to horse artillery, the following questions suggest themselves :—

1. Should it be attached to cavalry as heretofore, in order to prepare the way for the latter's advance, by firing the few rounds, permitted by time, under the most favorable circumstances ?

2. Should horse artillery accompany large bodies of cavalry acting independently in advance of an army; and, if so, how should it be employed ?

With regard to the first question, it was determined that it is no longer feasible to prepare the way for a rapid advance of cavalry by means of the fire of horse artillery guns ; for, whereas formerly, when the range of infantry fire was comparatively insignificant, and the pace of manœuvre of cavalry much slower, the batteries could often be pushed forward with safety to within case shot range of the enemy, and maintain a fire with considerable effect for some minutes; now, however, guns must perforce take up positions at great distances from an unbroken enemy; and even if we allow that, by the substitution of shrapnel for case, the actual efficacy of artillery fire has not been diminished, it must be borne in mind that much more time is required for the proper adjustment of the first named projectile, which if employed hastily, after the manner of case, is of little value.

It may be stated that, as a general rule, the cavalry divisions are posted on, or in rear of the wings, to execute flank and turning movements, and to protect their own troops from similar manœuvres on the part of the enemy. Such movements are usually brought about suddenly by some new phase in the feature of the battle, and will call for equally sudden deployments or changes of front on the opposing side, after which will take place, in all probability, a number of rapid charges, following one another in rapid succession, the result being decided in favor of the general, who is able to bring the last reserve to bear. Under such circumstances, the employment of artillery appears impossible, for its commander cannot intuitively grasp the plans of the cavalry commander, which are not preconceived, but determined and carried out on the spur of the moment, and which there is no time to

communicate to the artillery. If the latter pushes far and rashly to the front, it runs the risk of being isolated and cut off; if, on the other hand, relying upon the great range of the guns, it remains far in rear, so little time is left for its action before its fire becomes masked by its own cavalry that the correct range could rarely be ascertained. Again, should the cavalry be forced to retreat, the guns, which by the regulations of the Austrian service must take up positions to cover the movement, will tend rather to hinder than help the cavalry, which must look to the safety of the guns, while they, by their subsequent retirement at a gallop, will tend to increase confusion and spread panic.

The cavalry of the second line will rarely be brought into action before the decisive moment for pursuit or covering retreat takes place, while under those exceptional circumstances, when it is called upon to arrest the advance of the enemy's infantry without support from its own, to charge a battery which is causing serious loss, or to cover the retreat of portions of its own defeated troops, its attack must be essentially sudden and bold, and here there is certainly no scope for artillery to prepare the way. The magnificent charge of the Brigade Bredow at Vionville is a remarkable instance of such cases.

On the other hand, it was considered that horse artillery should accompany large bodies of cavalry, acting independently, and especially in large reconnaissances, and in the attack of positions, forcing defiles and such like operations, as well as in rear guard actions, when the retreat of an army is being protected. It also plays a very important *rôle*, when advancing with cavalry to sieze and occupy points of vantage, which it is important to hold till its infantry arrives, as did the 5th Division of Prussian cavalry with four batteries of horse artillery at the battle of Vionville-Mars-la-Tour.

When the cavalry is with the rest of the army, the horse artillery should pass over to the corps artillery of its own *corps d'armée*. This was invariably insisted upon by the Germans in the war of 70–71.

It is considered that the pace of horse artillery should very rarely exceed that of a trot, which is of far more practical utility than galloping, which shakes and damages the carriages, and flurries and unsteadies both men and horses, without any compensating advantage. Guns should be moved as seldom as possible. The construction and equipment of the gun carriage and limber should be such as to combine strength and mobility, with the capacity of carrying a sufficient number of rounds, to make the gun to a great extent independent of its wagon. All batteries, on peace as well as war establishment, should be armed with six guns, and the detachment should consist of five active numbers. The Austro-Hungarian horse artillery detachments are composed of ten men, all mounted; of these seven are with the gun, three with the wagon, Nos. 8 and 9 are horseholders with the former, No. 10 with the latter.

Note by the Translator.—Many of the above conclusions are by no means shared by the German horse artillery, which always prepares the way for the advance of a cavalry division, and which, as a rule, manœuvres at a very fast gallop. The occasions would appear to be very rare indeed when there is no opportunity for horse artillery to come into action and support the cavalry, with, at least, the moral effect of a few rounds fired at the object of the latter's attack.

(*Extracts from the "Revue D'Artillerie," Jan. 1881,*)

BY

CAPT. A. E. TURNER, R.H.A.

GREECE.

By a decree dated 29th April, 1880, the peace and war establishments of the artillery of the army of Greece were fixed as follows :—

Peace establishment.

1 regiment comprising 1 division of field and 2 of mountain artillery ; each division consists of 4 batteries. The head quarters and 2 field batteries are stationed at Athens, 1 field battery at Corfu, and the fourth at Lamia.

1 detachment of artillery train.

1 arsenal establishment at Napoli, consisting of a staff of a Lieut.-Colonel (Director), a Major (Sub-Director), and 6 other officers.

1 company of artificers (ordinary).

1 powder factory establishment.

1 detachment, special artificers.

1 ordnance store detachment.

The staff of the regiment is thus composed :—

1 Colonel commanding.	5 Adjutants.
1 Lieut.-Colonel second in command.	2 Surgeons.
3 Majors Commanding Divisions.	2 Veterinary Surgeons.
1 Lieutenant Aide-de-Camp.	7 N.-C. Officers.

The strength of the field batteries is :—

1 Captain.	18 Drivers.	
1 Lieutenant.	27 Gunners.	
2 Sub-Lieutenants.	7 Artificers.	Total ... 75
16 Sergeants and Corporals.	36 Horses.	
3 Trumpeters.		

Of the mountain batteries :—

1 Captain.	7 Artificers.	
1 Lieutenant.	24 Gunners.	
2 Sub-Lieutenants.	16 Muleteers.	Total ... 75
18 Sergeants and Corporals.	6 Horses.	
1 Trumpeter.	16 Mules.	

The total strength of the regiment is 64 officers, 221 sergeants and corporals, 36 trumpeters, 591 privates, 272 horses and 128 mules.

The artillery train consists of 2 officers, 6 sergeants and corporals, 1 trumpeter, 5 artificers, 15 drivers, and 27 horses.

The arsenal is under a Lieut.-Colonel, as before stated, with a staff of a major and 6 other officers.

The company of artificers consists of a captain and 5 junior officers, 1 chief mechanician (a civilian), 2 civilian firemen, 110 artificers, clerks, store keepers, &c., and 20 apprentices.

The staff of the powder factory consists of 1 captain, 1 lieutenant, 1 civilian (chief of the factory) 3 sergeants and 10 artificers (powder makers).

The detachment of special artificers is under a lieutenant aided by a civilian (artificer-in-chief), 2 sergeants and 11 rank and file skilled artificers.

The ordnance store is under a major, with a staff of 19 officers, 10 sergeant majors, and 5 clerks.

Total strength of arsenal establishment, 37 officers, 6 military artificers in chief, 38 sergeants and corporals, 2 trumpeters, 5 civilian artificers, 100 military artificers, 25 privates.

Before the above organisation was completed, the government of Greece, in consequence of their strained relations with another power, was compelled on the 5th August, 1880, to issue a decree for the immediate mobilisation of the army. No new field or mountain batteries were created, but the strength of each of the former was raised to 175 of all ranks, 32 riding and 120 draught horses; and of the latter to 182 of all ranks, 23 riding horses and 205 mules. Two batteries of position were raised, of the same *personel* as the field batteries, and formed into a division by themselves, also a depôt company of 1 officer and 28 men, a transport company to convey ammunition for the field artillery division, and two transport companies to carry that for the two divisions of mountain artillery. Each of the companies consisted of:—

2 Officers.	4 Artificers.
7 Sergeants and Corporals.	60 Muleteers.
1 Trumpeter.	

Total 74, with 10 horses and 61 mules.

Thus, the war strength of the whole of the artillery, including its special transport train, is 3,300 of all ranks, 1,190 horses, and 2,350 mules, with 84 guns; the total fighting strength of the army, as mobilised, being 42,590 men, 3,280 horses, and 7,540 mules, with 7,500 non-effective and 450 horses; the latter comprising depôts, gendarmerie, manufacturing establishments, &c.

Armament.

The field and mountain batteries are armed with Krupp's field guns, 7·5^{cm} (about 2·91 ins.) The two batteries of position with Krupp's 8·7^{cm} (about 3·43 ins.) field guns, the latter batteries are equipped but not horsed, as the supply of horses is unequal to the demand. Two more batteries of the latter calibre have been ordered from Krupp.

A reserve of 36 guns, system *La Hitte*, are at present in the arsenals at Napoli, Corfu, and Chalcis.

In addition to the projectiles turned out by the factories at Napoli, the following have been ordered from private firms:—38,550 common shells for the 7·5^{cm}, and 4,800 for the 8·7^{cm} guns; 18,790 shrapnels for the former, and 2,080 for the latter.

The horses, most of which are purchased abroad, and especially in Hungary, are small, but tractable, and of good constitution, they much resemble the Algerian horses in the French service. 1,600 were ordered from Hungary, when it was determined to mobilise the army, each costing at least 600 francs, delivered in Greece.

HOLLAND,—*War Budget, 1881.*

The sum voted for the army for the year amounts to 47,160,000 francs (21,935,000 florins); among the items appear,—

700,000	florins	for new field guns.
400,000	,,	for new fortress field guns.
299,000	,,	for two guns, for coast defence, with carriage and platforms, and experiments; (these two guns are for Fort Harssen).
1,950,000	,,	for fortifications.

The war strength of the army is to consist of,—

Infantry	41,000	
Cavalry	2,300	
Field artillery ...	4,000	and 120 guns.
Garrison artillery...	8,000	
Engineers	2,510	
Hospital Corps ...	750	
Train	2,800	
Total ...	61,360	

The artillery (on war footing) to be organised as follows:—

Field Artillery.

3 regiments, each of 6 batteries of 6 guns, forming 2 divisions (*Abtheilungen*), 1 regiment of 4 batteries, and 1 of 2 batteries, and 2 companies of train. A division of horse artillery of 2 batteries, and a battery of instruction for the depôts.

Garrison Artillery.

4 regiments, each consisting of 10 companies; 1 regiment is employed exclusively for manning the coast defences.

ALDERSHOT,
March 13th, 1881

EXTRACTS

FROM THE

"ORGAN DER MILITÄR-WISSENTSCHAFTLICHEN-VEREINE,"

Parts 5, Vol. XXI., and 1, Vol. XXII.,

TRANSLATED BY

LIEUT. J. M. GRIERSON, R.A.

THE four most important articles in these two numbers of the "*Organ*," are the "Armed strength of Russia, Part 2," by Captain Opacic; the "Medical Service in the German Army," by Dr. Bock; "The Russo-Turkish War (hitherto unpublished documents);" and a most interesting lecture by Captain Medycki, 9th Regiment, on the "Tactical Lessons of the War of 1877–8."

In the first of these is described the organization of the Russian reserve troops. In the infantry there exist in peace 1 guard and 96 line reserve cadre battalions, the former of 4, the latter each of 5 companies. On mobilization, the guard battalion is expanded into a guard reserve regiment of 4 battalions. Each company of the line battalions is expanded into a battalion; the first four form a reserve regiment of infantry, the fifth a new reserve battalion. The total number of the battalions thus formed is 484. The reserve infantry regiments are numbered consecutively from 165 to 260, and grouped by fours into the 42nd to 65th Infantry Divisions, *i.e.*, consecutively after the series of regular infantry divisions. The necessary men are obtained by calling in the reserves, and, if those are insufficient, the 1st category of the militia. The newly formed "reserve battalions" do garrison duty in the interior, while the 42nd to 65th Divisions are destined to support or re-inforce the field army. The Russian army has 192 regiments of infantry (including guards and grenadiers), and 7 brigades of rifles, and for those in war 199 depôt battalions are formed, 164 by 82 of the reserve battalions, which each form 2 depôt battalions for the line infantry; the guards, grenadiers, and rifles forming their own depôts. Each company of the above 82 reserve

battalions has in peace 42 files, those of the other 14, 38 files.* To provide artillery for the above divisions, there are six reserve artillery brigades, each of six batteries of four guns. Each sub-division is on mobilization expanded into a battery of eight guns, by calling up the reserves. The 1st, 2nd, 3rd, and 4th batteries of each brigade thus become each a brigade of 4 batteries, making a total of 24 brigades = 96 batteries, which are attached to the 24 newly formed infantry divisions, Nos. 42 to 65. The 5th and 6th batteries each form four depôt batteries of eight guns, each brigade thus furnishing a depôt brigade of eight batteries. $6 \times 8 = 48 =$ the number of regular brigades of artillery (41 line, 3 guard, 4 grenadier), thus each depôt battery feeds a corresponding regular brigade. The cavalry reserve squadrons merely train remounts in peace, and act as depôts in war, the divisional cavalry for the above divisions being furnished by Cossacks of the 2nd and 3rd categories.

In Dr. Bock's paper, we only notice the description of the barrack-town at Dresden for 7000 men. All the military buildings of the garrison are concentrated at the north end of the town in the so-called Albertstadt, which is intersected by the Königsbrücker Strasse, leading from the Elbe bridge. On the right side of the road, going away from Dresden, are three large barracks, each for an infantry regiment of three battalions, with immense drill sheds attached, a barrack for a pioneer battalion, the arsenal, train and clothing depôts, cadet school, hospital, and laboratory. On the left hand side are a military prison, the commissariat stores, several large riding schools, and barracks for one cavalry and two artillery regiments (17 batteries). Beyond all is an immense drill ground with broken ground all round it, over which manœuvres are carried on. The barracks are all new, and provided with the latest improvements, and the hospital is a model establishment. It is worthy of note that in the barracks the men sleep and eat in different rooms, and that the stables are quite apart from the mens' quarters.

In the papers on the Russo-Turkish War several curious revelations are made. It appears that in the summer of 1876, the German Emperor said to the Grand Duke Nicholas, "You will soon be called upon to take command of a large army and show your military talents." Considering that Russia was then at peace, this was rather a startling thing for a foreign sovereign to say in public, and it proves that an understanding existed between Russia and Germany. Or was Kaiser Wilhelm also among the prophets? Nicholas was totally ignorant of the intended war, and, on the 29th October, asked the Tsar if the war

---

Translator's Note.—To make the above more clear let us take an example,—

Peace Footing.		War Footing.	
1st Reserve Cadre Battalion Staff (St. Petersburg)		becomes Staff 165th Regiment.	
1st Company	becomes	1st Battalion 165th Regiment.	
2nd "	"	2nd "	" "
3rd "	"	3rd "	" "
4th "	"	4th "	" "
5th "	"	1st Reserve Infantry Battalion.	
Formed from all the companies	...	2 depôt battalions for Infantry Regiments.	

was to be against Austria, or, in short, what was the object to be attained? The Tsar's laconic answer was "Constantinople." The plan of operations reads curiously when looked at by the light of after history. The Danube was to be reached and crossed in a month, in three days the Balkans were to be reached, in five more Adrianople taken, and two weeks thereafter the Russian eagles were to float over the Bosphorus. And all this was to be done by four Army Corps, one of which was to remain in Roumania, one was to guard the communications in Bulgaria and the Balkan Passes, and the remaining two were to deal the Turkish death blow! Not till the last moment, and then only on the persistent prayers of the Grand Duke, were three more Army Corps of the Tsar's cherished troops thrown into the scale. Before such stupendous presumption, similar mistakes made in more recent military operations by two of the Great Powers of Europe pale. It must be confessed that the Russian precautions for keeping their point of crossing secret were perfect. Till the day previous, the Tsar even did not know where it was to be, and he was used as a decoy duck by the Grand Duke to draw the Turkish attention to Nicopolis. The wail of poor General Krüdener, who commanded there, and believed he was to lead the way across the river, sounds almost melancholy. "Oh, why did you deceive me?" he cried to the Tsar, when he marched into Simnitza. In several ways the presence of the Sovereign was hurtful to the army. In the first place his guard absorbed nearly an Army Corps. Again, he interfered in the councils of war, and very nearly succeeding in preventing Gourko's movement towards Orchanie, and his crossing the Balkans, one of the few operations which relieve the dull uniformity of blundering throughout the campaign. Much else there is in those interesting papers which the limits of a résumé prevent our inserting, and the perusal of them (Part 5, Vol. XXI., of the "*Organ*,") would well repay anyone desirous of studying the history of the war behind the scenes.

Captain Medycki's impressions on the lessons of the same war are most instructive to his hearers (the paper was read in the *Militär-Wissentschaftlichen-Vereine*, in *Olmütz*) in plain, clear, and soldier-like language. His object is to point out the good and the bad points in the conduct of the campaign on both sides, and thence to draw his deductions. From the beginning, both sides committed grave strategical mistakes. The Russians began the war with totally insufficient forces, for which they were punished by Plevna, and the Turkish army was all split up, the three main bodies being wide apart, and quite independent of one another. They received their orders from the Council of War in Constantinople; consequently all spirit of initiative was crushed out of their leaders, and, in the author's opinion, they neglected the one thing needful to hold the line of the Danube—a double bridge head at Rustchuk-Giurgevo, or Turtukai-Oltenitza. The wisdom of the choice by the Russians of the point for crossing the river cannot be denied, and the measures taken for deceiving the Turks (bombardment of Rustchuk and Nicopolis, concentration of boats opposite the latter, &c.), the barring of the river by torpedoes, the strict secrecy observed, and

the excellent arrangements for bringing up the troops to the point of crossing are worthy of the closest study. Besides the evident lessons to be drawn from the above, Captain Medycki counsels the careful study of all new engines of war, so that an army may not be surprised by the enemy using a new weapon, as the Turks were by the Russian torpedoes. The author then observes that it seems to him that this campaign was planned by an eminent strategist who himself was not on the spot, and that, when one operation went wrong, the whole collapsed, and there was no one in the army able to set the unwieldy machine moving again.* The Russian cavalry did nothing. Osman Pasha appears in front of a column of Russian infantry, the Shipka garrison vanishes in a summer night, and many other instances might be brought forward to prove how utterly ignorant of the "*service d'exploration*" the Russian horsemen were. The lesson to be drawn from this is obvious.

The Russian army is drilled to perfection, but this very perfection was a snare to it, for, when its antiquated formation for attack was found to be inapplicable to modern conditions of fighting, it was found that the men could not be got to advance in any other, in short, the want of intelligence among the rank and file prevented their adopting a new system of tactics, as the Germans did in 1870, in the middle of a campaign. It was this blind adhesion to the tactics of a past age which ruined the Russians in 1806. In the battles before Plevna, the author finds that in six points the Russians failed. (1.) They did not reconnoitre the enemy's position sufficiently. Troops should be trained to reconnoitre in peace, and there is no more favorable time for doing this than during the route-marching season. A few men sent out will serve to represent an enemy, and those wearisome exercises will thus be made interesting. (2.) They attacked with forces numerically insufficient and separated from one another; the attack was conducted on no fixed plan, and was only frontal, and the proper feeding of the fighting line was misunderstood. In the first battle of Plevna the 5th Division (9000 strong) was spread over a front of 28 kilomètres (4¼ paces per man), and the two main columns were 8 kilomètres apart. (3.) The three arms of the service did not work together. (4.) The proper point of attack was not selected. (5.) The Russian formations were not suitable to the conditions of modern warfare. (6.) Proper use was not made of the arms they possessed, although those were far inferior to the Turkish weapons. Against this may be urged the splendid bravery of the troops, and their predilection for the bayonet. "The bayonet is a good fellow, the bullet is a fool," said old Souvaroff, and his lessons are remembered in the Russian army to this day. The Turks are accused of not taking advantage of their victories, but against that may be placed their clever system of field fortification, and the excellent use they made of their rifles and guns. Into all the observations of Captain Medycki we have not here space to enter, but can heartily recommend his paper as one of the most interesting criticisms of the 1877–8 war we have read.

Translator's Note.—We have heard this opinion as to the foreign origin of the plan of campaign strongly supported in certain foreign military circles.

NOTES

ON THE

AUSTRIAN FIELD ARTILLERY SERVICE PRACTICE,

AS INTRODUCED IN 1872.

COMMUNICATED BY

COLONEL W. H. GOODENOUGH, R.A.

Introductory.

Although issued some years since, the subjoined passages from the instructions given out when service practice was first begun in Austria may prove of interest and value at the present time.

Matter peculiar to the Austrian service, or affected by the armament in use nine years ago, has been omitted in making these extracts.

One of the principal difficulties we labour under in introducing service practice as part of our regular system of instruction in the United Kingdom, is that of finding ground proper for the purpose.

For this reason, the translator regards the instructions for procedure in acquiring land for ranges as of much interest, and he has given them almost *in extenso*.

We are in the habit of thinking that, on the Continent, all such matters are managed with a high hand, and that there can be no difficulty in the troops acting as they please. It will be seen, however, that property is scrupulously, though not exclusively respected. We may be led to find that where others succeed through throwing the task of finding suitable ground on the branch interested in the service, decentralising the negotiations, and minimising the novelty of the proposition in the eyes of the local people, making as little fuss as possible about it, in fact; we too, in spite of our vastly different country and population, following a similar course, may get what we want.

For efficiency, service practice should be done annually by every battery. This is impracticable with only three or four land ranges available in the United Kingdom. But the writer believes that, if we set about it methodically, many more places would be found where field artillery could fire. He may be exaggerating the requirements, but, roughly speaking, he looks on a clear space of four miles down the line of fire, with three-quarters to one mile on each side of it at the

extreme of the range, as giving all the conditions of safety. Let the ordnance map be examined by the light of some such conditions as these. In each district it would soon be found where such free spaces may possibly exist, and a visit to the spot would determine the rest.

Salisbury Plain in the south, and the slopes of the Cheviots, or some of the hills near the Border, in the north, suggest themselves. Ireland should have no lack of sites, and in view of the small sums that are, and should be, payable as compensation, we may yet hear it said of the needy Irish cotter, as it used to be of the insurance-loving German peasant, "that a fire was a benefit and a hailstorm a blessing, but a visit of the troops at manœuvres a real godsend."

It is by no means necessary that the precise same ground should be resorted to in recurrent years; on the contrary, in many particulars, advantage would be found in changing the ground in successive years; many proprietors, too, would like this better.

The writer has witnessed service practice by the Austrian artillery, and he was impressed by the degree to which the firing was carried on "as on service" in respect of rapidity, and by the regularity and method of the whole of the proceedings. Particularly advantageous appeared to him the division of labour in the following particulars:—

Command, and superintendence of fire, as to elevation, fuze, &c.

Observation of effect of shot: The fire of the whole battery is directed by one officer who, in a loud voice, orders the elevation, &c., for each round or series, correcting himself by the ascertained result from all the guns. The regulations on this head are given in translations issued with R.A. Institution Proceedings, No. 3, Vol. VIII.

The Provisional Instructions of 1872.

The objects of the service practice were thus defined:—

The annual course was not comprised in it, but it was to come as a wind-up to that course.

The responsible officers, N.-C. officers, and "*numbers*" were, through its means, to study:—

The exercise of choice as to object, or part of object, to fire at.

The choice of projectile, and effect of latter as influenced by ground.

The observation of result of fire (impact of shot and burst of fuze), and of the deceptive influence which the fall of the ground has on the judgment.

The errors made in estimating ranges, and the corrections proper thereto.

Choice of positions; their advantages and disadvantages, both as regards one's own and the enemy's position; and further:

The relative amount of security troops may enjoy through their formation, through the way they occupy the ground, and from different sorts of cover.

* * * * * * * *

The following is taken from the instructions for selecting and acquiring ground for the service practice :—

The best ground is that most resembling ground on which actions are commonly fought; moderately hilly ground, affording variety of cover, and not impossible for any arm. A proportion of wooded ground is advantageous. Cover, such as natural features, or enclosures and cultivation afford, should be made use of in the interest of the practice as far as owners and occupiers will permit.

Practice grounds are not to be too far from home; if troops arrive fatigued it is a drawback to their instruction. If, however, ground at a distance must be used, batteries may bivouac on the ground. The District Commanding Officer of Artillery would make his proposition to this effect when sending to the War Ministry his programme of operations for the current year.

Compensation for use of ground for service practice is determinable with sole reference to the damages caused thereby. Referring to points 1 and 2 below, these damages can be but small.

The following is the usual procedure in selecting and acquiring the right of use of ground for service practice :—

The ground having been reconnoitred and a plan of it made, the necessary arrangements with the civil service authority of the district are entered on; all that is done is to appoint a commission, composed of representatives of the commanding officer of artillery, of the Commissariat Department, of the Construction Department (with us the R.E.), an official from each civil district concerned, and the representatives of the chiefs of the *communes*. These visit the ground, determine approximately the lines of fire, and seek the consent of the proprietors and of the chiefs of *communes*.

In order to obtain this consent more readily, the military representatives are enjoined to give prominence to, and lay stress on the following points :—

1. That the intention is to practice manœuvres, at which some of the firing will be with real projectiles—not to use the ground as a regular artillery practice range.

2. The shooting to take place after harvest time, and only in the fore or the afternoons for a few hours at a time: any ungathered crops to be thoroughly respected: existing roads only to be used, by preference, in moving the batteries to their positions.

3. That such small damages as occur through explosion of shells will be settled by ready money payment at the end of the practice, equitably, by mutual consent. Failing mutual consent, the amount payable to be settled by a commission.

4. That no troops will be quartered on a *commune* in consequence of the practice, except under urgent necessity.

5. That closing roads and keeping the ground as requisite for safety will be attended to, and traffic and agricultural operations will be inter-

fered with only so far as necessary and unavoidable The military will, where practicable, respond readily to the wishes of individual owners as to changes in position of targets, and such matters.

When an arrangement has been arrived at in this way with the *communes*, the commanders of military detachments are strictly responsible that the troops abide by, and in no way infringe on it. Only thus can the use of the ground be assured for after years, or the danger be avoided of frightening the proprietors of such other grounds as may subsequently be wanted. Forcible proceedings are at all times to be avoided. Battery commanders are liable to make good all damages which themselves could have prevented.

* * * * * * * *

Placing of Objects for Fire.

Planks of $5\frac{1}{2}$ ft. represent single men standing. Planks of $2\frac{3}{4}$ ft. represent single men kneeling. A section of infantry is represented by 24 dummies in a line 20 paces long, or by planks at equal length, $5\frac{1}{2}$ ft. high, with figures marked out thereon. A company of Infantry in line by four of the above.

Other objects, and mounted men and cavalry in a similar manner. All such dummies to be painted grey or blue so as not to be conspicuous. No bull's-eyes or cross-lines to be marked on objects, but Nos. 1 to adhere, in laying, to the points indicated to them by battery commanders.

Only as many objects to be set up on one occasion as may be required that day. Fresh objects to be set up in the afternoon for the next day's practice. The officer in charge of this duty to have his precise instructions given him immediately before they are to be executed.

In placing objects of fire regard must be had to formation of ground. Natural or artificial cover, similar to what would be met with on service, to be used, so as to exhibit its advantages. Similarly, objects are to be placed sometimes in front of, sometimes behind, rising ground, because, in the first case, corrections for laying have to be made differently from what would be the case on a plain, and, in the second, the observation of effect is rendered very difficult. A peculiar difficulty in judging effect of shot is occasioned when an object is placed on a ridge; it may show itself clearly against the sky, but shots which go over cannot be judged.

Precautions for Safety and General Instructions.

Besides the posting of vedettes, as necessary to ensure safety, it is directed that village authorities be made acquainted a few days before with the days, hour of commencement, and probable duration of the several practices, in order that they may warn their people.

A regular committee is to be appointed to take down the results of fire consisting of a field officer, two battery commanders, and two

subalterns with N.-C. officers and men. These are placed so as to observe the strike of shots and action of fuzes, and they keep the range report. To this latter it is well to attach a sketch of the object and of the positions of the batteries, showing also the relative heights.

* * * * * * * *

The tactical idea governing any practice is to be imparted to the battery commanders shortly before its commencement. These, then, acquaint their subordinates with its outlines. Immediately thereupon the battery is ordered to move to the ground which the superintending officer has reconnoitred for it. The object to be fired at is indicated to the battery commander, either immediately before the march to the place were it will be formed, or during the march, and when the battery has reached a suitable point whence it can take up its position. After this the battery is left to the sole management of its commander, who proceeds according to regulations.

Nos. 1 take as their mark the middle of the object. With a column, it is the leading portion of it which is laid upon. When troops in close order have skirmishers in front, it is not these, but those in close order which should be fired at.

The first shots are trial shots. They must be watched with peculiar care, in order that the proper corrections may be made and the range be picked up rapidly. As a leading principle, trial shots should be short rather than over. The officer charged with observing the shot should have a simple method of signalling his observations to the battery, so that they may be used in correcting elevations, and be not capable of being misunderstood.

* * * * * * * *

It may be arranged that batteries, after firing at one object, should suddenly turn their fire on another, supposed to be threatening them, but generally this should not be done unless there has been a marked success in the firing at the first object.

At the close of the firing, the whole of the men engaged should be taken to see the result on the object, and be instructed as to their success, or its absence, and its causes.

In the above practice, the ranges should, in general, not exceed 2000 paces, in order to accustom the batteries to regard the shorter ranges as those used for decisive action, and the longer as exceptional.

The officers, N.-C. officers and men of batteries not engaged are to witness the practice of the other batteries; they are to be placed as near as may be to the object, so as to give them an opportunity of acquiring, by their own observation, correct ideas and experience as to the use and effect of their weapon; their commanders and officers giving them suitable instruction, and commenting on the progress and result of the practice.

[*The Form of Record of Practice is annexed.*]

FORM OF RECORD

Date.	Battery.	Number, nature, and position of guns.		Number and Nature.				Range, paces.		Object.
				Total rounds fired.		Fired as trial shots.				
				Full charges.	Reduced charges.	Full charges.	Reduced charges.	As judged.	Actual.	
Day, month, year.	Battery No. ..... of the ..... Regiment of Artillery.	4 rifled .....-pounders.	Position near Village of D.....	20 common shell.	—	4	—	1450	1500	Company column deploying (sketch annexed) on the ridge of ..... Hill. The leading section fully, the remainder partially visible from battery. Line of fire as in sketch.
			Position by Farm L.....	20 common shell.	—	3	—	1600	1650	Battery of 6 guns in action, with 3 ammunition wagons in rear partly concealed by bushes. *Detachments represented.* 3 mounted N.-C. O. 5 men per gun. 2 " wagon. *Teams represented.* 19 mounted men per gun. 18 horses per gun. 3 mounted men per wagon. 3 horses per wagon. Object placed in hollow-way leading from *m.* to *n.* Line of fire direct on front.
			Position at	—	—	—	—	—	—	—

Dated at .....,

the ..... *day* ....., *188*... ..

OF PRACTICE.

Result of Fire.	Common Shell. Prematures.	Common Shell. Blind.	Shrapnel. Prematures.	Shrapnel. Blind.	Weather.	Remarks.
Direct Hits of Shell.						
1st section 2	—	—	—	—	Dry air. Bright. Light breeze.	
2nd " 3	—	—	—	—		
Total ... 5						
Hits from Splinters of Shells.						
1st section, 11 through, 3 not through	—	—	—	—		
2nd " 13 " 4 "	—	—	—	—		
3rd " 7 " 2 "	—	—	—	—		
4th " 5 " 1 "	—	—	—	—		
... ...	—	—	—	—		
Total 36 " 10						
Total Loss of Column.						
5 men by direct hits	—	—	—	—		
34 " splinters	1	—	—	—		
Direct Hits.						
3 and 4 guns dismounted	—	—	—	—	Slight rain. Violent, gusty wind.	
1, 3, and 4 gun wheels broken.	—	—	—	—		
3 men in No. 1 gun	—	—	—	—		
2 " No. 4 "	—	—	—	—		
2 mounted men in team of No. 1 gun	—	—	—	—		
3 " " " No. 5 "	—	—	—	—		
1 " N.-C. officer in No. 2 Subdivision ...	—	—	—	—		
Splinter Hits.						
– through, 3 not through at No. 1 gun	—	—	—	—		
– " 5 " " No. 2 "	—	—	—	—		
– " 7 " " No. 6 "	—	—	—	—		
3 " 1 " " detachment No. 1 gun	—	—	—	—		
2 " 2 " " " No. 3 "	—	—	—	—		
5 " 1 " " " No. 5 "	—	—	—	—		
2 " 3 " " " No. 3 wagon	—	—	—	—		
Total Loss of Battery.						
m. Guns dismounted...	—	—	—	—		
n. Mounted N.-C. officers	—	—	—	—		
o. Men of detachments	—	—	—	—		
p. Mounted men in teams	—	—	—	—		
q. Horses	2	—	—	—		
—	—	—	—	—	—	

(Signed) .....

Inspecting Field Officer.

NOTE
ON THE
PRUSSIAN MODE OF INDIRECT LAYING OF GUNS.
CONTRIBUTED BY
MAJOR VAN STRAUBENZEE, R.A.

Instances may occur, where the target, although visible from some point in rear of the gun (by a man standing on the limber, &c.) cannot be seen from the position the gun is in.

In such cases, an auxiliary mark, on which to lay, can be used, the mode of proceeding being as follows :—No. 1 having fixed the tangent scale to a convenient height, making, if necessary, an allowance for wind, &c., on the deflection scale, places himself in rear of the gun, in a position whence the target can be seen, and, by aid of a plummet and line, or by eye, orders the gun to be traversed, as nearly as possible, on to the line required.

Returning to the gun, and having previously selected an auxiliary mark visible therefrom, he then moves the deflection leaf till the line of sight is on the auxiliary mark, giving elevation by clinometer (the construction and use of which is explained to the men), to the extent required for the range to the target.

By raising or lowering the tangent scale (after the elevation is obtained), and clamping it when the gun is correctly layed on the auxiliary mark, the "point" layed on, affords the means of giving the necessary elevation for after rounds, without using the clinometer. If, however, a clearly defined "line" only is used to lay on, elevation must in all cases be given by clinometer.

The instructor explains, that, whilst the axis of the gun is directed on the target proper, the auxiliary mark only affords a visible point on which to lay.

In selecting the latter, it is important to remember, that one at the same range as the object, and rather above it, is the most favourable, and one beyond it preferable to one in front of it; also that the nearer it is to the battery, the greater the deviation, due to slight alterations on the deflection scale.

If no natural mark presents itself, a picket or banderol placed in the ground, as far as convenient from the battery, will answer as an auxiliary mark.

It is important that the gun should be run up to the same spot after each round.

When desirable to open fire from a position (in rear of the brow of a low hill, or other natural cover), whence the target is not visible from the rear of the battery, two pointing rods, or pickets aligned on the target, between it and the gun, will afford an accurate means of obtaining the line, the elevation being given by clinometer as before.

N.B.—It would appear that even should the object be visible from the gun, if indistinct, or partially obscured, indirect laying might be employed with advantage, especially at long ranges.

EXTRACTS

FROM THE

"MEMORIAL DE ARTILLERÍA,"

TRANSLATED BY

CAPTAIN J. C. DALTON, R.A.

The February number of the "*Memorial de Artillería* opens with a minute description of the Portuguese Artillery.

The service is governed and constituted much the same as in Spain.

Tables are given showing the exact composition of regiments of Garrison, Mountain, and Field Artillery, both on a peace and war footing.

The guns used by the *Field Artillery* are 9^{cm} steel Krupp guns with Broadwell ring, and, by the Mountain Artillery, rifled 8^{cm} short bronze guns on the French system.

The 9^{cm} gun weighs about $9\frac{1}{4}$ cwt., and with its carriage, about $35\frac{1}{2}$ cwt., with limber and 5 gunners on it 40 cwt., which gives about 7 cwt. to each mule. On a war footing a Field Battery has 6 guns and 6 wagons, 3 G. S. wagons and 1 forge.

The *Mountain Batteries* are armed with 8^{cm} M. L. bronze guns.

It describes further the ammunition carried, the system of recruiting, nature of the animals (horse and mule) and regulation height, the uniform, &c.

The carbine in use is a Minié converted into B. L. Snider-Burnett.

The officers are armed with six chambered revolvers on Abaddie system.

The pay of the different ranks is given, that of a Captain looks very imposing on paper, viz., 55,000 Reis per month, or about £11 10s. For the practical instruction of the regiments of Artillery, and to conduct experiments, &c., the Corps possesses a camp near Veudas-Novas in the province of Alentejo, which is reached by rail from Lisbon. This camp is officered by a permanent staff, and, to a certain degree, corresponds to our Shoeburyness. The different artillery regiments all take a turn at this camp. There is a laboratory and workshops, topographical department, &c. The troops while undergoing their

course there are taught how to throw up fortifications, hasty defences, to form siege batteries, and similar works. Various sorts of practice from different kinds of ordnance are carried on here, including experiments with machine guns.

The *Gun Factory* is at Lisbon, and here guns, projectiles, fuzes (metal) and material for apparata and instruments of all kinds for military service are made.

There is also a *Small Arms Factory* near the above, where everything connected with small arms is attended to, also a carriage department, so far as the wood work is concerned, also saddlery and harness department, and, lastly, cartridge case department, metallic and otherwise.

Gunpowder Works at Barcasena, 14 kilomètres from Lisbon.

Pyrotechnic Works at Braco de Prata, 7 kilomètres from Lisbon. All incendiary compositions are made here, and the cartridges filled; also the fuzes and tubes driven.

Lastly, the system of education for the Artillery, both to obtain a commission and afterwards, are described. The course is a severe one. There is also a theoretical and practical school specially for N.-C.-officers.

At page 149 of *Memorial* for February, 1881, there is a very sensible and practical article on "Field Batteries in the Camp of Instruction and Practical School."

The author divides it into two heads; under the first he treats of theoretical instruction, and under the second of practical, viz.:—in shooting at targets, judging distances, &c.:—

1. He mentions having advocated these improvements in the present system of instruction a year ago, but apparently little has been done to carry out his propositions.

He draws attention to the advice given at page 474 of the *Memorial* of last December, and quotes from the article therein on the German Artillery—"Nothing should be taught that is not absolutely useful in time of war. Drills and practical work should be undertaken under circumstances as difficult, or if possible more so, than those that occur in war." He criticises a number of apparently aimless manœuvres practised in the Spanish Artillery of to-day, and complains that time spent over them is wasted. Amongst such, he mentions the manœuvre of advancing and retiring in action, and remarks on it—"One of the principles of modern warfare is, that batteries should change position as little as possible, and that once in a position, should remain in it as long as practicable; but, that if obliged to change it, the advance or retirement should never be for a shorter distance than 500 to 600 yds., and must be done in a manner not to hamper or affect in any way the fire of other batteries that may succeed to the position, &c."

He objects to such trivial details as dressing guns in action and when arriving in a position, and considers that officers get in the way of paying more attention to these minor matters than to the all important ones of obtaining cover and good positions, to ensure safety and

accurate shooting. Officers and Nos. 1 should be accustomed at once to select the best positions for their divisions and guns, with due regard to the situation of the object and the class of fire they have to employ. He quotes from General Gourko's remarks on the manœuvres of the Russian Artillery the year before (1878),—"To form up in exact alignment of batteries and of guns is quite unnecessary, each battery should try to occupy a good position, taking care not to interfere with the fire of others."

The author states that, in his opinion, all these petty details of exact dressing of carriages, drivers all raising their whips at the same moment when moving off, &c., are very "pretty for field days, as a spectacle," but are neither practical nor of use for battle field formations.

Brigade drill also, he urges, especially in Mountain Artillery, might be greatly simplified; battery drill being so much more important; because on service batteries nearly always move independently. It should not be forgotten that in Germany, Field Artillery drill is entrusted entirely to the Officers Commanding Batteries, "whose mission it is to *prepare the battery for war.*"

He says, "Batteries should possess mobility, and be fit to take the field, not merely to appear well at a review;" and he deplores the fact that the Spanish Artillery appears to be devoted to the latter rather than to the former. As a general rule, once driving drill and battery drill has been learnt, the 8^{cm} batteries (which in war time would be Horse Artillery) should invariably manœuvre at a trot and gallop; but this is of course impossible so long as Spain allows her light batteries to be drawn by mules. These animals, that Spain alone employs for Artillery draught, cannot move fast, and if they could, the drivers could not stand it.

On the other hand, those armed with the 9 or 10^{cm} guns, as well as the Mountain Artillery, should be practised at a walk, but should be accustomed to every sort of rough ground that might possibly fall to their lot, and give up drilling on level ground, which teaches nothing. "We should not mind if a horse or mule fall, or if a carriage upset, or a pole break—so much the better, to give the men an opportunity of speedily rectifying the accident."

He mentions that all these different cases of disabled ordnance, &c., though well explained in the 3rd Vol. of their *Field Artillery Exercise*, are not sufficiently taught and practised.

Defensive and offensive positions should be taken up constantly under all conditions, and the dispositions timed and criticised. Practice replacing men, horses, and ammunition, taking care that, in the latter case, the particular nature expended be replaced, and that boxes directly they are empty be replaced by full ones.

He recommends the system adopted in the Belgian Artillery of keeping a certain number of batteries complete at war strength, and letting all officers and men become accustomed to these by giving them a periodical course with these batteries.

Marches, short manœuvres on new ground, billeting, encamping, embarking and dis-embarking batteries on railways should be practised within a certain radius of the district the batteries are stationed in.

Also at certain periods general manœuvres of all arms—as in other countries—in which camping, bivouacking, picketing, foraging, outpost duties, accessory defences, positions in case of alarm, &c., should be studied.

2. The author recommends that the course of the regular annual practice be divided into three parts—(1) range finding and judging distance, (2) aiming drill, and (3) shooting at targets. He only treats of the last, the importance of which is fully recognised by all officers. The Germans now no longer fire at known, but at unknown ranges, and against objects similar and similarly situated to those that would be met with on service.

In Spain, expense is so much considered, that several important reforms have to be neglected or to be slurred over, but the writer tries to impress on his readers the fact that "if armies in peace time prepare for war, the expenses they incur will be the more fully recouped the higher the perfecting of both theoretical and practical instructions attains to; and then when critical times do arrive, economy is secured, and above all, the blood of our soldiers is spared, and the honor and glory of our arms maintained."

He puts the minimum number of rounds per gun per diem at 8, and names 20 days as the time the practice should last, and all classes of ammunition should be used during that practice, according to the varied circumstances of warfare.

It is a notable fact that though there is in Spain a central school of musketry for the Infantry, who possess but one weapon, there is no school of gunnery for the Artillery.

The "Proceedings" of the R.A. Institution of England say,—"Artillery may be likened unto the Queen at Chess, it may be a source of weakness, according as it is employed." Major Von Schell of the German Artillery writes—"The value of an Artillery is measured by the quality of its shooting." The author accordingly advocates spring manœuvres, where all details pertaining to Artillery Instruction should be carefully carried out, and the Select Committee of the Corps (*Junta Superior Facultativa*) after examining the results of the exercises and practice, should award prizes to both officers and men who prove themselves the best gunners. Also, in a General Order, the best regiment and the best battery in each regiment should be noticed.

The Engineers have an annual camp of instruction at Guadalajara, and the author hopes that the Artillery which attend that camp, may, for the future, be able to afford more effective help to their sister service than they have hitherto done.

This concludes the remarks of the writer of this article, and there can be no doubt in any Artillery Officer's mind as to the soundness of them. Although the writer does not intend this evidently as an essay on the subject, but rather as a means of drawing the attention of his own countrymen to what is specially needed in his own service still there is in it good practical advice to all belonging to the Artillery arm, and if all he advocates were practised, much good must accrue therefrom.

We may say that we do adhere to most of what the writer lays down as so essential, and very probably we do the utmost in that way in our Horse and Field Batteries that circumstances permit, but in how many of our stations do we get ground other than the most level field in the neighbourhood, on which to do all our outdoor work? Aldershot and the Curragh are about the only stations where we can get the advantage of driving over rough ground, taking up positions, co-operating with other arms in field days, out-post duty, &c., and the latter of these places even, is far from presenting much scope for either the driving powers, or fertility of resource in taking up positions, of our Artillerymen. A great step has been taken in the right direction by the establishment of practice camps annually on Dartmoor and at Hay, and if *every* battery could only have a good spell of one of those places each year, and autumn manœuvres with the other arms afterwards (say every other year) more would be learnt in a month than is now learnt in a year on the drill field.

But then, again, the great question of money comes in, and though we are not hampered, happily, as much that way as Spain is, still with our present external and internal troubles, money must be saved, and batteries therefore cannot be moved about so freely, and those at outstations do not get the advantages of practice grounds and autumn manœuvres, &c., as they should.

HOLLAND.

The Dutch have made three guns of steel-bronze for their Horse Artillery, and these have undergone a very satisfactory proof.

They shoot as well as the English, German, Austrian, and Italian field guns; though not quite as well as the French, nor as the 8·4^{cm} made by Krupp for the Swiss Government.

After 1000 rounds the guns were none the worse, and the steel-bronze appeared to possess all the requisite qualities for a metal of which to make guns.

At page 207 of the February Number of the "*Memorial de Artillería,*" mention is made of a telescope invented by M. P. de Broca, and described in "*Les Mondes, Vol.* 53, *No.* 11.

The object of this is to lay guns at long ranges, and it is destined to complete his previous invention of the double sight for Artillery on land. It is founded on a particular principle of "large field" telescopes, which gives us the power to see, at the same time, objects both at a long distance from those we are laying on, and also those which are

very close to the eye, such as the tangent scale and the sight on the gun, in size proportionate to that of the object glass of the telescope. We can with this optical apparatus, lay as correctly as when simply looking over the sights with the naked eye at short ranges, and no special mechanism is needed to bring the optical axis into exact relation with the different lines of sight of guns.

The telescope is worked by hand, bringing the object glass against the sight, or else by placing it on a support on the breech of the gun; which latter is the more convenient way.

This valuable effect is obtained by employing a convex and achromatic half lens, cut exactly in the centre, which intercepts the passage of the luminous rays.

ERRATA.

Page 667, line 2 from top; for "1872" read "1881."
„ 668, „ 13 „ „ "Ifax" „ "Sfax."

THE FRENCH IN AFRICA.

From the Deutsche Heeres-Zeitung, 20th August, 1872.

BY

CAPT. T. ROCH, R.A.

The latest campaign in Africa shows one of the most dangerous blunders which any nation, or more correctly speaking, that nation, whose government undertakes such an one, ever committed. It was commonly thrown in the teeth of the French, as every one knows, during the Franco-German war, that they had won easy victories in Africa, but were unable to stand against disciplined troops. The taunt was well founded and yet was not. There was no army in France which could successfully withstand the Germans, but there was an army in Algeria which held the Arabs in check, and would have defeated the Germans on the burning soil of Africa. After their overthrow—when the French set to work to re-organize their army—they naturally turned to the system of their conquerors for a model, and they forgot, in doing so, that France was also an African Power and needed an African army. They still kept, indeed, an African rifle regiment, but this hardly suffices to guard its own garrisons. In the days when service in the French army was for seven years, the men were only sent to join the African army after they had served three years with the colors, and were therefore inured to hardship and discipline, and thus they had four more years to serve, and, after one year's sojourn, were fit to cope with the Arabs, to endure the heat, thirst, and toil of marches, and, moreover, had learnt the art of warfare peculiar to that country. Besides, the re-engaged men were also at hand—non-commissioned officers in particular, well acquainted with the country and its inhabitants—good men to show the way, and especially well adapted to instruct the last-joined recruits in the peculiarities of warfare in those parts.

Now all that is changed. The period of military service is reduced to three years, the soldier scarcely passes two years with the colors, the *cadres* are incomplete, and if it be possible to carry on a successful war on the Continent with such a system, in Africa it must always entail disaster. The latest expedition to Tunis has shown this. In many respects the army is superior to that of 1870. Officers and men

were duteous, disciplined, and obedient to orders, they bore without grumbling, hardship, privation, and even sickness. It was a stout young army for garrison duties, but, truth to tell, it appears to have been extremely difficult to keep the men together under fire; not that they ran away, indeed, but that they showed themselves over well inclined to get under cover. They were stout recruits, but not soldiers. They had been told what terrible people the Kroumirs were. They had seen the body of one of their comrades—who had fallen into the hands of the enemy—horribly mutilated, and each one thought, when a shot came from behind a bush, that it was aimed at him. How could the country lads, who had been brought straight from the plough, have learnt what the horrors of war are?

At Ifax the Admiral, who justly interpreted the state of affairs, declined to land the infantry. He did not dare to send them against an enemy protected by earthworks, who appeared resolved to fight to the last, and to hold out as long as a man was left. It was the marines (proved, tough men, hardened against mishaps, and who had undergone their baptism of fire) who carried the batteries at the point of the bayonet with a coolness which excited admiration, and burst open the gates, thus inspiriting the infantry of the line by their example. When the latter saw how a Naval Lieutenant advanced coolly under fire, tore down the green flag and hoisted the tricolor in its place, they entreated to be allowed to take their part and advanced bravely. This leaves no room to doubt that the country lads are well fitted to be made into soldiers, but they require much more time, strong *cadres*, and the strength of manhood. The present African army is composed of too young soldiers, they are not fit to bear the hardships and the climate without the *cadres* being filled up, they have not had time to be transformed from recruits into African soldiers. Official high-coloring cannot alter the fact, and France will not possess an African army until she possesses one composed either of natives or of seasoned French soldiers.

EXPERIMENTS CARRIED OUT BY HERR KRUPP AT MEPPEN,

27th February and 5th March, 1880.

COMMUNICATED BY

MAJOR C. H. FAIRFAX ELLIS, R.A.

(From the Report issued by Herr Krupp.)

Continuation of Experiments with 15^{cm} Gun, 28 Calibres long.

Trial of Armour Plates at Angles of 90° and 55°.

The experiments begun on the 18th November, 1879, with 15^{cm} gun, No. 283, were continued.

On the 27th February, 1880, a steel shell, 3½ calibres long, was fired direct at a 12-inch wrought-iron plate, and two similar shells at an 8-inch wrought-iron plate, at an angle of 55°.

On the 5th March, 1880, a steel shell, 2·8 calibres long, which had been put on one side as somewhat too soft, was fired at a wrought-iron 8-inch plate at an angle of 55°.

The charge for all four rounds was 37·48 lb. of 7 hole prismatic powder of 1·75 density. The results are given in the table. They show that,—

1. In direct impact, the 3½ calibre Krupp steel shell, (like the 2·8 calibre steel shells in the experiment of the 18th November, 1879) did not break up, and was hardly at all deformed, notwithstanding the high striking energy of 2,308 ft. tons.

2. The 15^{cm} steel break up on striking an 8-inch plate, at an angle of 55°, with an energy of 2,300 ft. tons.

In another experiment, a 17^{cm} Krupp steel shell completely perforated a 6-inch plate with strong backing, at a striking angle of 55°, and with an energy per inch circumference of 5,921 ft. tons.

Further experiments will show if it be possible to increase the stability of the steel shells.

3. The soft steel shell, as might have been expected, had set up before breaking. The *vis viva* was also less than that of the 3½ calibre shells, so that its effect, even under favorable conditions, would not have been so great; as compared to chilled shells, however, the effect was much greater, and for chilled shells of the same weight only made indents of from 3·94 inches to 4·33 inches, whereas the soft steel shell nearly penetrated the 8-inch plate.

4. In direct impact, the 12-inch plate was perforated, with some energy to spare, by the 15^{cm} steel shell, with a striking energy of 126·25 ft. tons per inch of circumference.

5. The 8-inch plate was perforated, with considerable surplus energy, at a striking angle of 55°, by the 15^{cm} steel shell, with a striking energy of 127 ft. tons per inch of circumference.

Date.	Gun.	Number of round.	Charge, 7 hole prismatic.		Projectile.	Velocity at 100^{m} (109 yds.) from muzzle.			Pressure tons per square inch.		Energy.
			Weight.	Density.		Chronograph.		Mean.	Rodman apparatus.	Crusher gauge.	
						No. 292	No. 293				
			lb.	28·6 / ·970							ft. tons.
27. 2. 80.	Long 15^{cm} gun, No. 283.	1	37·48		Steel shell.	1739	1739	1739	19·91	20·41	2341
	Calibre, 5·87 inches.	2	"	"	3½ cals.	1720	1731	1725·5	19·89	20·47	2303
	Length of bore, 148·9 inches.	3	"	"	long, 111·64 lb.	1749	1752	1750·5	20·28	20·87	2373
	Length in calibres, 25·4 inches.				Mean	1736	1741	1738	20·03	20·59	2340
5. 3. 80.	"	4	"	"	Steel shell, 2·8 cals. long. 85·43 lb.	1906	1908	1907	18·97	18·45	2154

A. *Direct fire at a 12-inch wrought-iron plate from the Dillinger Works.*

Range, 164 yds.

1. Striking velocity ... .. 1726 f.s.

" energy ... ... 2308 ft. tons.

Plate perforated ... ... Hole 5·99 inches × 6·34 inches.

Struck 15·75 inches from left, 13·8 inches from top of plate vertical through crack; 79 inches wide at top, from top of hole to top of plate.

In rear.—Moulds broken away over 17 inches × 17 inches to a maximum depth of 3·86 inches.

The shell was picked up 33 yards in rear of plate, the point was warm. It had set up ·21 inch in length, and from ·04 inch to ·05 inch in diameter.

B. *Oblique fire* (55°) *at 8-inch wrought-iron plate from the Dillinger Works.*

2. Striking velocity ... ... 1713 f.s.
   " energy ... ... 2271 ft. tons.

   Struck 27·95 inches from top and 49 inches from right edge of plate.

   Through. Hole 6·3 inches × 15 inches.

   The left side of hole forms an angle of 45° with face of plate. Moulds in rear are bent back 9·8 inches. Small fragments of plate up to 64 lb., were thrown 109 yards to the rear.

   Shell broke up, pieces picked up 440 yards in rear. Right side of hole in plate scored by fragments of shell.

3. Striking velocity ... ... 1736 f.s.
   " energy ... ... 2332 ft. tons.

   Through ... ... Hole 6·3 inches × 13 inches.

   The left side of hole forms an angle of 49° 15′ with the face of plate.

   Moulds in rear bent back 7·1 inches.

   Small pieces of plate projected 164 yards to the rear.

   Shell broke up. Fragment of base found in front of plate, fragment of body in hole in head, 8·7 inches long, found at 2,187 yards and 56 yards left.

4. Striking velocity ... ... 1890 f.s.
   " energy ... ... 2116 ft. tons.

   Shell glanced.

   Scoop 23 inches long. Small hole through 3-inch diameter. Moulds in rear broken away and bent back 3·95 inches. Shell broke up into large pieces. Head split.

SHORT DESCRIPTION OF SMALL STONE-WALL FORT THROWN UP FOR TWO 7-PR. R.M.L. JOINTED GUNS OF No. 1 BATTERY, 8TH BRIGADE, (MOUNTAIN BATTERY) AT CAMP THULL, DURING THE AFGHAN WAR OF 1879-80.

BY

LIEUT. T. V. W. PHILLIPS, R.A.

The Fort was built on a naturally prominent position at the N.W. corner of Camp Thull, on hard rocky ground, with a thin layer of soil over the rock, and large boulders dispersed about here and there. The walls consisted of large stones laid close together, and the interstices filled up with mud and small stones; these stones were obtained from other parts of the camp, the ground being too hard to cut a ditch and build up the parapet in the usual way.

The accompanying compass sketch was done with a pocket prismatic compass, the contours being put in by means of a plummet attached to a protractor. At first sight it may appear that the battery, being considerably lower at the N.N.E. corner, could be easily enfiladed from that quarter. This, however, was not the case, as the ground over which an enemy could have approached from that direction was so very much below the battery that the low parapet formed a traverse of itself. Still, if it had been intended for defence against an enemy possessed of good shooting weapons at long ranges, it would have been necessary to build up the parapet wall higher, and fill in that corner up to a level, or nearly so, with the other end of the battery, to have prevented being enfiladed from a distance.

As regards the camp itself and its approaches, the guns were in a most commanding position, the only hill that overlooked it being considerably out of range of the enemy's rifle fire, and the crest of which was occupied from retreat to daylight by a strong picket.

A small proportion of ammunition was kept ready in leather boxes in rear of each gun; the remainder being kept at the foot of the hill from where it could be brought up under cover at the shortest notice; though we slept several nights in the battery, ready for rumoured attacks just before daybreak, I do not think it had an opportunity of proving itself useful under fire, except for sheltering the sentry from occasional pot shots during the night.

The rough pen and ink sketch is intended to represent the fort as it appeared from the N.W., or as one approached Thull along the road from Kurrum.

Occ

Dra

ROUGH SKETCH OF GUN-BATTERY AT THULL.

Looking at it from the approach from Kurrum.

Part of main camp. with the Transport lines below.

The Battery.

Commissariat guard tent and round tower for sentry.

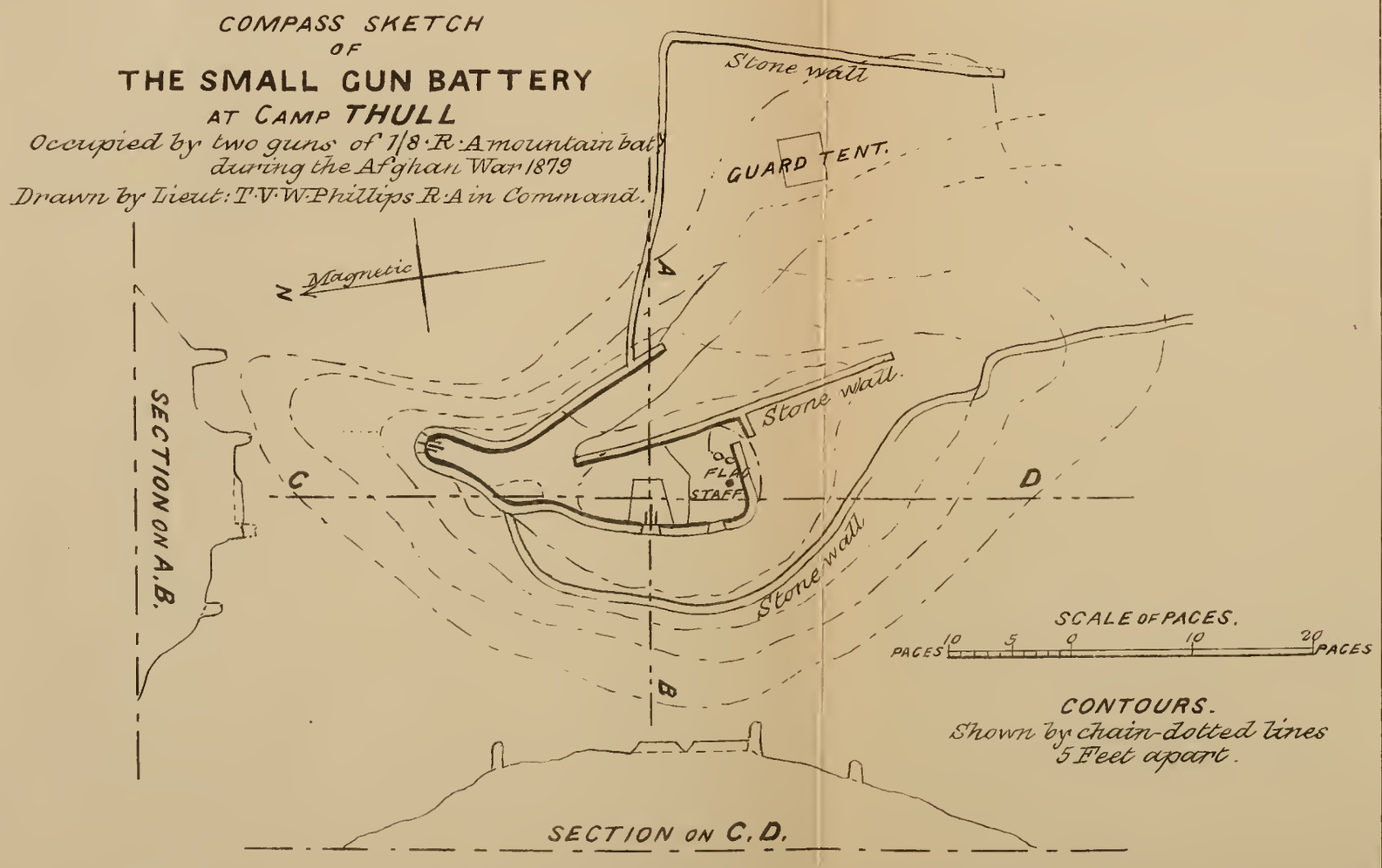
Post office tent.

COMPASS SKETCH
OF

THE SMALL GUN BATTERY
AT CAMP **THULL**

Occupied by two guns of 1/8 R.A mountain batty during the Afghan War 1879

Drawn by Lieut: T.V.W. Phillips R.A in Command.



THE

TRAINING OF "POINTEURS" FOR ARTILLERY.

(*From the French.*)

BY

LIEUT. H. C DUNLOP, R.A.

---

1. The book, of which the following is a short *résumé*, is entitled, "*Instruction Provisiore sur la formation des Pointeurs, dans les corps de troupe d'Artilerie*," and is published by the "*Libraire Militaire de Berger Levrault et Cie.*" *Rue des Beaux, Arts. No. 5.—Paris.*

"Pointeur" is the number whose duty it is to lay the gun.

2. Every recruit is put through an elementary course of laying with tangent scale and foresight, and with quadrant.

His capabilities are judged roughly, as follows :—

A small white target is placed about 60 yards away. On this target is a moveable black disc with a hole in its centre, through which a pencil can be inserted and a mark made.

The instructor lays on some point on the target, and the gun and sights remain fixed while the recruit looks over the latter, and has the disc moved into what he considers to be the line of sight by a man stationed at the target for the purpose. A dot is then made with a pencil through the centre of the disc. The disc is moved to a new position, and the recruit again looking over the sights has it adjusted, and its position marked on the target in the same manner as before. This operation is repeated several times. Finally, the instructor, looking over the sights, has the true position of the disc recorded.

The pencil dots thus obtained by each recruit in five consecutive layings are joined by straight lines, and the dimensions of the polygons thus formed are used as a means of comparison as regards accuracy in laying.

Due regard being paid to skill in the manipulation of the tangent scale, quadrant, &c., as well as to these polygons, the best recruits are now provisionally selected as "pointeurs," and receive further special instruction in laying.

3. (*a*) Ordinary laying with the tangent scale and foresight.

(*b*) Laying with sights and quadrant.

(*c*) Laying with sights, quadrant, and plumb-line.

(*d*) Laying with the sights, quadrant, plumb-line and pointing-rods.

(*e*) Laying by means of an auxiliary mark. This method is employed whenever it is impossible to lay the gun directly on the object by means of its sights, or when the object is *not clearly defined*. The point may be chosen either in front or in rear. It should be as far away as possible, and should be clearly defined. The gun should always be brought back to the same position after recoil.

(*f*) Correcting the elevation. This is done by giving so many extra turns, or portions of turns, to the hand-wheel of the elevating gear, except when the correction is large, when the tangent scale is reset.

(*g*) The use of the deflection leaf.

(*h*) Measuring the inclination of the trunnions, and showing practically what is the effect of their inclination. The inclination is measured by the quadrant, and a rule is given similar to our formula:—"Inclination of trunnions in degrees × elevation in degrees, = deflection in minutes towards the higher wheel."

(*i*) Laying on a running target.

(*j*) Miscellaneous recapitulation.

The men are now practised in laying on distant objects by all the methods already enumerated. They are never allowed to alter the elevation and deflection ordered.

4. The final Classification of "Pointeurs."

A "pointeur" should be able to satisfy the following conditions:—

To give without hesitation the elevation ordered, either by means of the tangent scale or the quadrant; and similarly the deflection.

To lay with regularity and rapidity.

Further, the "pointeurs" of each battery should lay with uniformity.

5. The following example is given as a means of assisting in the final selection of "pointeurs." The exact method employed must vary according to circumstances.

A target with a moveable disc, as already described, is placed near a mark on the barrack wall.

(*a*) All the guns are laid on the disc, and its position marked.

(*b*) Without moving the guns, the tangent sights are altered so as bring this wall-mark into the lines of sight.

(*c*) The guns are slightly traversed and elevated.

(*d*) Relaid on the wall-mark with the deflections and elevations obtained, as described in (*b*).

(*e*) Without moving the guns, the original elevations and deflections are given, and each "pointeur" in succession has the disc moved to suit the line of sight he has thus obtained. The distance between the present position of the disc and its original position shows the accumulated error of four sights and of two readings of the tangent scale.

6. "Pointeurs" are not finally selected till after really firing.

Each man fires five shots with plugged shell—the first one is a trial shot and does not count. Ricochets do not count.

Selected "pointeurs" from each battery compete with other batteries for prizes. The first three men receive a distinguishing badge.

There is no mention made of these men having to undergo any preliminary paper examination.

7. Comments.

The French do not assume that because a man happens to be a non-commissioned officer he must be the best shot.

Every man's laying powers are tested, and those who show themselves most capable are carefully selected to lay.

All through the instruction, great stress is laid on the man doing exactly as he is ordered; he is not allowed to make any corrections for himself.

The means of correcting the elevation, by giving (so many) turns to the hand-wheel of the elevating gear, is specially useful when firing at a running target, when time is often of great importance.

A considerable portion of the instruction is given to laying by an auxiliary mark. This plan involves no calculation, and, where the object is ill-defined, a great saving of time is effected in the long run, and cover can often be obtained.

Corrections for direction and distance are given independently of the distance of the auxiliary mark. They depend on the range of the object; of course, the correction for elevation must not be given directly from a scale of yards, unless the tangent scale happens to be nearly at the proper height for the true range.

The deflection leaves of our service sights (with a few exceptions) are not long enough to make the teaching of this method of much practical use, but French's sights are admirably adapted for the purpose.

The means of employing the target with the moveable disc, as described in para. 5, is objectionable, as errors might neutralize each other. If this method is to be used, the instructor should look over the sights after each operation, and disqualify any man who commits gross errors.

The plan described is para. 2 is not liable to this objection; but, I think, if a greater number of dots were used, and a probable rectangle for these dots worked out for each man, a more reliable basis for judging would be obtained.

The great advantage of employing the target with a moveable disc is that the "pointeur" can actually *see* his errors. The main objection to its use is that it affords no criterion of laying capabilities at long ranges, and at objects such as one would meet with on service; but, happily, the system admits of ready development in this respect.

8. All that is required is a large pane of glass in place of the target, and an iron cross instead of the disc.

The method pursued would be as follows:—

(*a*) Lay the gun on the distant object.

(*b*) Bring the glass target into the line of sight at a distance of about 100 yards from the gun.

(*c*) Raise * the tangent scale and alter the deflection.

(*d*) Bring the cross into the line joining the tangent scale notch and the object.

(*e*) Mark the position of the cross on the glass target. (This can easily be done with a pen and a piece of soap.)

(*f*) Move the cross to any new position.

Keep on repeating (*d*), (*e*), and (*f*) till the required number of marks are obtained on the glass target.

9. Speaking generally, the Prussian system, of which there is a translation by Major T. Van Straubenzee, R.A., resembles the French. Would it not be advisable for us to modify our drill, and to make the duties of laying independent of rank; and would it not be a beneficial reform to abolish the preliminary paper † examination in our annual competition, substituting in its place a practical examination, conducted on the general principles described in paras. 2 and 8 of this paper?

* This is necessary, as otherwise the fore-sight would be of assistance in the subsequent operation.

† This examination might be retained as a qualification for promotion, or for an independent prize.

THE BATTLES OF LAING'S NEK AND INGOGO;

WITH BRIEF NOTES ON THE

9-PR. GUN OF 6 CWT., AND GENERAL EQUIPMENT.

BY

LIEUT. C. S. B. PARSONS, R.H.A.

LAING'S NEK.—*28th January, 1881.*

ON the expected outbreak of hostilities in the Transvaal early in December, 1880, urgent orders were issued for the immediate despatch of troops to Newcastle, Natal, an insignificant dirty town bordering on the Transvaal, but, from its situation, peculiarly adapted as a base for military operations. The signal for the Boer outbreak was the departure for India of the King's Dragoon Guards, the only cavalry regiment left in S. Africa after the conclusion of the Zulu war, as well as the downward march from the Transvaal of the 58th Regiment, one of the three infantry regiments left to garrison the Transvaal. The reason for thus withdrawing troops was the popular belief that the Boers were quite satisfied with and reconciled to British rule, and that there was no further occasion for keeping a stronger force than two infantry regiments to garrison a country larger than France. This idea was very erroneous, as was shortly shown by the action of the Boers at Bronker's Sprint, when the 94th suffered so severely. War was now virtually declared. The force of artillery available to be moved with the first column from Maritzburg, consisted of two 9-pr. 6 cwt. guns, comprising the left division of N/5, R.A., and two 7-pr. 200 lb. mountain guns on low standing carriages, manned by volunteers from 3/60th Rifles, and drawn by mules driven tandem.

These four guns, escorted by four companies of the 3/60th Rifles, the whole under the command of Lieut.-Col. Ogilvie, 60th Rifles, left Maritzburg, on the 21st December, 1880, and after a most trying and difficult march, reached Newcastle on the 2nd January, 1881. The heavy rains prevalent in S. Africa during the winter season had rendered the roads almost impassable. The first march from Maritzburg was most trying to all, and found us at Howick (a charming little village 14 miles from Maritzburg) without food and without tents—the transport wagons having broken down in their attempt to get up the long

and continual ascent from Maritzburg. In consequence we had to bivouac, and buy bread and meat from the stores in Howick. The wagons with our tents came up in the afternoon of the next day, the 22nd December. We remained that night at Howick, and proceeded the next day on our way to Newcastle. Every precaution was taken during the march; wagons laagered at night; scouting parties thrown out during the day; and outlying picquets posted at night, &c. The English horses during this trying march worked admirably, and we had no galls and no sickness, which was rather remarkable as horse sickness was very prevalent everywhere. Our only difficulty was in the shoeing, as after a march over heavy and stony roads, many horses cast their shoes, in consequence (according to the veterinary surgeon) of the horses hoofs getting dry and hard during the twelve months' stable life they had been leading at Maritzburg. The little mountain guns we brought along with us very easily, considering the heavy roads and the low standing carriages. They of course easily and continually upset, but were just as easily put right again. The ammunition for these guns was carried on two high wheeled Scotch carts, peculiar to the country, drawn each by six mules. Two mules for the gun, driven tandem, were found quite sufficient.

In addition to the four guns already mentioned, the late Captain Greer, R.A., drew out of store at Durban two 9-prs. of 6 cwt., that had been returned to the Ordnance Department soon after the termination of the Zulu war; and these guns, drawn by bullocks and manned by garrison gunners from 10/7th Brigade at Cape Town, he brought up to Newcastle, joining us about the 20th January, 1881. The three weeks we spent at Newcastle previous to Greer's arrival were chiefly employed in buying and breaking in horses for his two guns. Cape horses proved very unsuitable for draught purposes, on account of their general light build and bucking propensities; but fortunately we managed to get from horse farmers living in the Newcastle district some of the dragoon horses they had only a few weeks previously bought at the government auction sales, on the King's Dragoon Guards embarking for India. With the help of these horses and one of the wagon teams of N/5, R.A., as a something to go upon, we managed to put together two scratch gun teams of eight horses each, driven by garrison gunners, assisted by the three wagon drivers of N/5, R.A., who went over to those guns with their horses. The two ammunition wagons of these guns, 10/7 Brigade, R.A., as well as the one wagon of N/5, R.A. that was unhorsed, were drawn by bullocks; thus we had—

N/5, R.A. Guns and one wagon well horsed with English horses, and one wagon with bullocks.

10/7, R.A. Guns horsed with a mixed lot of horses, and two wagons with bullocks.

The late Major Poole, R.A., suggested that as the horses were untrained and the garrison gunners unable to ride or drive, the horses should be driven with reins from the limber boxes, but this was found to be impracticable. With the help of the three wagon drivers,

however, and spare drivers from N/5 R.A., who drove in the lead and wheel of 10/7, the garrison gunners got on very well with their field guns, and were quite serviceable for slow manœuvring.

The general concentration at Newcastle was completed about the 22nd January, 1881, the whole force being thus approximately made up—

Artillery, { Two 6 cwt. 9-prs. of N/5 R.A.
Two 6 cwt. 9-prs. of 10/7 R.A.
Two 7 pr. guns manned by 3/60th Rifles with N.-C. O's. from N/5 R.A.

3/60th Rifles. Six companies under Lieut.-Col. Ashburnham, 3/60th.

58th Regiment. Seven companies under Major Hingeston, 58th Regiment.

Mounted troops. 250 mounted infantry, A. S. Corps, and details of K. D. Guards, who had been waiting at Pieter-Maritzburg under orders to join their depôt at Canterbury, under Major Brownlow, K. D. Guards.

Naval Brigade. 150 men with rockets and gatlings, under Commander Romilly, R.N., from H.M.S. Boadicea.

Natal Mounted Police. 100 men under Major Dartnell, N. M. Police.

On the 24th January, 1881, at daylight, the force moved out from Newcastle under the command of Major General Sir G. Colley, accompanied by a train of a hundred or more bullock wagons laden with provisions. Mount Prospect Camp, about 16 miles from Newcastle and 4 from Laing's Nek, was reached on the 26th January—an excellent spot for a fortified camp, with abundance of water and good grazing for horses and cattle. Although nearly surrounded, it was nowhere commanded by the Drakensberg Range, and afforded a full view up the valley, enabling us to watch all the movements of the enemy. As we fully expected they would make cattle raids, and try and sweep off our cattle grazing in the vicinity of our camp, two guns were always on cattle guard under an officer.

The 26th of January was so foggy and wet that the General determined on postponing his forward march till the following day; so we spent the 26th in strengthening our wagon laager and spying the Boers on the surrounding hills with our field glasses. They sometimes came down scouting into the valley below, riding across our right front about 1000 yards off and offering a very tempting target to our guns; but the General would not allow us to fire.

On the 28th January, we moved on to the attack, starting at daylight with the object of taking Laing's Nek. The two guns of N/5, R.A. were the rear guard and the last to leave the camp; but being more mobile and better horsed than the other guns, Sir G. Colley (after the force had crossed the river at *E*) ordered these guns up to the front, and sent them on at a gallop, escorted by Natal Mounted Police, to hold *A*.

10/7 then moved on and held *A'*, and N/5 R.A. moved on to *A''*, the guns thus covering the general advance of the force.

At about 10 a.m. the action commenced with the guns opening fire on Laing's Nek, the range in the first instance being incorrectly taken by a range party under the command of an officer and skilled N.-C. O's., provided with Watkin's Range Finder. No greater facilities for range finding on service could possibly be conceived; yet there was an error of 450 yards, the range to the Nek given us as 2350 yds. eventually proving to be only 1900 yds. We began firing at the Nek at 2350 yds. with common shell, but never saw the shell; we then knocked off 200 yds. with no better result; and knocking off another 200 yds. we found the range to the Nek to be about 1900 yds. In the event of taking the range by trial shots, we had determined to lay the trial shot for a range of 2000 yds. Sir G. Colley, who was a great advocate for range finders on service, was greatly disappointed at the result.

The artillery deposition was as follows :—

N/5, R.A., on the left of the line, with orders to shell the Nek and the left front.

10/7 was on the right of the line, with orders to cover the advance of the 58th Regiment and Brownlow's charge, in conjunction with the centre division of 7-prs. under Lieut. Young, 21st Royal Scots Fusiliers. The artillery fire lasted for about half an hour, when the 58th Regiment were ordered to form for attack and proceed up the spur, with a view of taking the hill marked *B*, termed by Sir G. Colley the key of the position. Brownlow, with his mounted men, was ordered to charge up *C*, with a view of taking that ridge and clearing the spur, and then (by moving to *D*), preventing the flanking fire that afterwards had such a deadly effect on the 58th Regiment during their advance.

Brownlow's charge failed, but from no shortcoming on the part of that gallant officer. Although his horse was shot and he himself was slightly wounded, he managed to reach on foot the crest of the hill, and getting in among the enemy killed a Boer with his revolver. His escape was miraculous. He was nobly followed by Sergeant-Major Lenny, K. D. Guards, who was killed. Brownlow seeing his men could not come on, made his way back: the charge had failed, and the day was lost.

The artillery practice throughout this action was particularly good, as was testified to by one Aylward, an Irishman, once editor of the *Natal Witness*, who went over to the Boers on war being declared, apparently in the capacity of their military adviser, while at the same time acting as correspondent to an English newspaper. His account of the action at Laing's Nek was published in a Natal paper soon after the engagement. We had a difficult and delicate part to perform; having to keep up a constant fire over the heads of our own advancing and retreating infantry and mounted men, who were manœuvring on ground at a far greater elevation than that on which the guns were working.

After the failure of the range finder we endeavoured to guess the ranges, being very fortunate on one occasion when the enemy came down in strong force on our left front, and after seizing a strong *koppee*, or hillock, began harassing the Naval Brigade. We guessed

the range at 1200 yds., loading both guns of N/5, R.A., with shrapnel and directing them on this *koppee*. Both shells burst over the hill, dispersing the Boers and silencing the fire that we afterwards learnt had had a telling effect on the sailors.*

While Brownlow's attack was going on at *C*, the 58th Regiment, accompanied by Col. Deane, (late of the 19th Regiment, and formerly a cadet at the R. M. Academy), and several staff officers, among whom were Elwes of the Grenadier Guards, A.-D.-C. to Sir G. Colley; Poole, R.A., acting in the capacity of Assist.-Quarter-Master-General; Inman, 60th Rifles, Col. Deane's orderly officer; and Essex, the sole survivor of the staff officers, advanced to storm the hill, *B*, only to be met by a murderous frontal and enfilade fire. The enfilade fire was kept up by the Boers, who, having beaten Brownlow back at *C*, had gone along the spur and descended into the valley marked *D*, out of fire of artillery. This enfilade fire was most effectual, and the noble regiment was at length compelled to retire, their retreat being conspicuous for good order and regularity. Only after having lost half their officers and men, was the retreat commenced. A company of the 60th was sent out to cover their retreat, the remaining portion of the regiment unfortunately being able to render little actual assistance, as they were obliged to remain as an escort to the guns. Sir G. Colley throughout this action remained with the guns, often personally directing their fire.

The Naval Brigade were employed in firing rockets over the Nek, which they did with precision. The gatlings had been left in camp, together with other details, with the view of protecting the camp in our absence. Soon after the retreat of the 58th, about 2 p.m., Sir G. Colley sent his Military Secretary, Captain McGregor, R.E., under a flag of truce, up the road leading to the Nek, with an application for a cessation of hostilities, to enable him to recover his wounded and dead. Joubert, the Boer General, responded, saying everything on the slope up which the 58th had advanced belonged to him, but he would allow burying parties to come up, provided they left their rifles behind them. On this Sir G. Colley sent up burying parties, accompanied by Drs. Babington, Ring and Landon, and the Rev. St.-G. Ritchie, Chaplain to the Forces, whose gallant bearing throughout this action was most conspicuous.

About 3 p.m., Sir G. Colley commenced his retreat to Mount Prospect Camp, which was reached about 5 p.m.; and soon after our arrival Sir G. Colley paraded the force, telling us in a most generous and noble manner that all the *onus* of the failure was on his own shoulders, at the same time praising the gallant conduct of Major Brownlow, K. D. Guards, and his Sergeant-Major.

Throughout the night of the 27th the camp was kept awake by the rumbling of the heavy ambulance wagons coming in from the Nek with their loads of killed and wounded. This continued all night, and on the

* [At Mars-la-Tour—"it was observed that three (common) shell striking consecutively generally caused the enemy's column to retire." Hoffbauer, "Die Deutsche Artillerie &c." II. 45.—*H.W.L.H.*]

morrow we had a general funeral parade, when officers and men were interred in, as it were, one great family vault, in the vicinity of Mount Prospect. Camp life for the next ten days was indeed irksome and tedious. A mournful spirit pervaded the whole camp, and we were all impatient and anxious to be actively employed in once again attempting the capture of the Nek. There was nothing now, as we thought, but to hold our own and await the reinforcements that were being hurried into the country. Every day Boers were seen hovering around us, no doubt with the object of carrying out some cattle raid, or spying our movements. We seemed never to be able to gain any intelligence as to their losses, their numbers, or their plans. We offered them medical assistance after the action at Laing's Nek, which they respectfully declined, saying their slight losses hardly necessitated their acceptance of such an offer.

Every morning before daylight we were under arms, in expectation of an attack, and during the day we were busily employed in cattle guarding and building detached forts such as *F*, to strengthen our position. Early in February, the site of the camp was changed, and the usual wagon laager formed with guns and gatlings at the angles, horses picqueted inside, tents outside.

The duty of the R.A. in this action was mainly to cover the advance and retreat of the infantry and cavalry. Shrapnel shell was generally used with 15 secs. fuzes, at ranges varying from 1200 to 2200 yds. Number of rounds fired by the six guns, about 170. Casualties among the R.A., nil. The diagram represents the position of the troops about noon, when the 58th and mounted men had commenced their respective attacks.

INGOGO.—*8th February, 1881.*

On the 7th February, while attending the sale by auction of the effects of the poor fellows who were killed at Laing's Nek, we were rather startled to see the Newcastle post which had been despatched in the morning, return to camp. On enquiry it was ascertained that the post carriers, three in number, had been fired on by the Boers and prevented from crossing the Ingogo River.

In consequence of this, shortly after we had got under arms about daybreak on the 8th, Sir G. Colley gave us orders to have two guns (with one wagon) and the 7-prs. ready to start at 8 a.m. with the 60th Rifles. The object was, first, to make a demonstration by marching down to the Ingogo River; and, secondly, to re-establish our postal communication with Newcastle, which had been interrupted by the Boers.

No one thought there would be fighting. Sir G. Colley gave us orders to have dinners ready on the (expected) return of our force about 4 p.m. No provisions of any kind were taken, simply water-

bottles filled, &c. N/5, R.A., with their 9-prs., being more mobile and better horsed than 10/7, was detailed for this duty, together with the 7-prs.; and about 8 a.m., accompanied by five companies of the 60th Rifles, the force marched from camp. On arriving at the summit of the steep hill (marked A) leading into the Ingogo Valley, Lieut. Young, Royal Scots Fusileers, with his 7-prs. and an escort of a company of 60th, was detached and left behind, to guard our rear and hold the road between ourselves and Mount Prospect Camp. Sir G. Colley, accompanied by Captain McGregor as his military secretary, Lieut. Hamilton, 15th Regiment, as his aide-de-camp, Major Essex as his staff officer, and Mr. Stuart, the Resident Magistrate of the Ixopo District, as his chief Intelligence Officer, conducted the operations in person. Major Brownlow, K. D. Guards, with his mounted men, was all the time scouting and feeling the way for us. The descent was easily accomplished, the river crossed, and the plateau on the other side of the river reached when some of our scouts came in reporting the enemy to our front, which report was soon corroborated by sundry rifle shots which we could hear along our front. Sir G. Colley, on receipt of this news, immediately sent out the 60th Rifles in skirmishing order, ordering the 9-prs. to take up a position on a commanding eminence. This manœuvre carried out, a further advance was ordered, the 60th skirmishing in front of the guns until the high ground (marked B) about two miles from the river and on the main road was gained. The enemy we could now see were in full force in our front. The guns galloped into action, unlimbered and commenced firing shrapnel at the enemy about 1200 yds. range. The Boers seemed to be galloping in single file across our front, taking advantage of the undulating ground to quickly get under cover. The first two shells from the guns had little effect, as the range had not been accurately guessed; and even had we been in a position to trust and use range-finders, time did not allow of their being of any practical advantage on this occasion. The Rifles all this time were crowning the plateau and lining the edges. We were commanded nowhere. Brownlow was presently driven in on us, and the action began in earnest about 12 midday. The guns were in action, playing on small parties of the enemy galloping across our front and flanks, evidently with the object of surrounding and forming a complete cordon round us. At about 1 p.m. the firing was very hot. The Boers, leaving their horses in their rear well under cover, were creeping up the slopes to the crests of the plateau that we were lining, keeping up all the time a most deadly and telling fire. Excellent shelter was afforded them by the nature of the ground and the huge rocks and boulders that abound everywhere in this part of the country. Until about 2 p.m. the action was continued with ever-increasing vigour. Greer, R.A. had been killed by a bullet through the head about 1.30 p.m. while superintending the boring of fuzes at the trail of one of the guns. His last words to me were,—"Can you let me have some men? mine are nearly all down." It was not possible to comply with his request: there were no men to give him. M'Gregor, R.E. was shot while carrying out the orders of Sir G. Colley; and Mr. Stuart,

Chief of the Intelligence Department was killed just in rear of the guns about the same time. Eventually the guns commenced firing case upon the enemy who were almost on the very crest of the plateau, about 300 yds. from us. All the case were soon expended, and we then used shrapnel shell inverted, with an indifferent result. However it sufficed to prevent the enemy charging the guns, as we feared they would do. The Rifles held their ground most gallantly, suffering terribly all the time. The enemy's fire throughout seemed to be concentrated on the guns, and the casualties among the gunners, drivers, and horses were very heavy, some of them being caused by buck-shot. However the fire of the artillery never slackened, thanks to the noble assistance rendered us by the Rifles who when our gunners were nearly all down, rendered us every possible assistance. The order to retire the guns came about 4 p.m. Not having sufficient gunners to limber up, the drivers dragged their dead horses out of harness, and, assisted by the Rifles, manned the wheels first of the limbers and then of the guns.* Two Drivers, Rowlands and Woods, N/5, R.A., and two of the 60th whose names I regret to say I have forgotten, were wounded when manning the wheels to get the guns out of action. The intrepidity of Bombr. Hyde, R.A., was so marked that he was promoted to the rank of Sergeant, and recommended for a Distinguished Conduct Medal. Great, too, was the gallantry of Driver Cording, and of Gunner J. Page (now of G/B., R.H.A.), who was also recommended for a Distinguished Conduct Medal; and the cool and cheerful way in which Sergt.-Major Wilkins, 60th Rifles, went about encouraging the men was the theme of universal praise. Young Maurice O'Connell, of the 60th, as brave a young officer as ever took the field, having been told off in command of the few men forming the General's personal escort, and finding little to do, applied to rejoin his company in the fighting line on the crest of the hill. His application was granted, and immediately on joining his company the poor fellow was mortally wounded, and died after an hour's intense suffering.

The guns being thus withdrawn to a somewhat less exposed position, opportunity soon offered for continuing the firing in another direction, as strong reinforcements of the enemy were seen coming down from Laing's Nek and forming up in the Ingogo Valley beneath us. From our experience with our first two shots in the action we fairly guessed the range, and landed two shrapnel in the midst of the enemy, dispersing them in every direction.

The fight went on with continued vigour until darkness fairly put an end to the hostilities. Sir G. Colley now determined to take the guns and the remnants of his force back to camp, leaving the killed and wounded, and the ammunition wagon on the battle field. By taking all the riding horses for draught purposes and by leaving the wagon behind, just 12 horses were found fit to hook into the two guns, and about 8 p.m. Sir G. Colley moved off the field. As much as possible of the ammunition contained in the abandoned wagon was carried off,

* [At Mars-la-Tour—"at an early hour the losses among the gunners were so great that drivers, and frequently officers also, were obliged to assist in working the guns." Hoffbauer, "Die Deutsche Artillerie &c.," II. 75.—*H.W.L.H.*]

and what was left behind was nearly all destroyed by burying fuzes and destroying cartridges before Sir G. Colley and what remained of his force left the ground. It was an anxious time for those who were left behind. Little did we think that Sir G. Colley would ever get back to camp, naturally supposing that the enemy would effectually oppose the passage of the river. What from want of water and extreme bodily pain, the sufferings of the wounded and dying left on the Ingogo battle field are indescribable. Men were dying all around, and crying out continually during the night for relief from the terrible thirst they suffered. About 10 p.m. a fearful thunderstorm, accompanied by vivid and frequent flashes of lightning which lit up the awful scenes around us, broke over our heads, and a driving rain drenched us all to the skin. We lay all night expecting every minute to hear our men engaged with the enemy; but it was not so, and the camp was reached by Sir G. Colley just at daylight. He immediately sent Lieut. Carroll, R.A. with fresh horses down to the battle field, to bring up the ammunition wagon that was left behind. This officer went down, hooked his horses in, and took the wagon down into the drift; but he found the river had risen so much that he was unable to cross, and there was no alternative but to unhook and leave the wagon in the river. He eventually arrived at Newcastle by a circuitous route; having had to avoid the battle field, since the Boers in the interim had come in in large numbers to visit the scene of the fight and witness the result of the action.

A little before daylight those who had been left on the battle field were delighted to see Dr. Ring and Dr. Lauden arrive with a few hospital comforts and water carts with water for the wounded. Fires were immediately lit, and beef tea and brandy given to the poor fellows, for some of whom there could be no hope. Poor Haworth, 3/60th, said he was so parched with thirst, that during the rain he gnawed the gun blanket that covered him for moisture for his lips. About daybreak on the 9th February some four or five Boers came on to the battle field under a flag of truce. We asked them to dismount and offered them some brandy and water, of which they freely partook. They expressed great sorrow for all that had happened, and asked concernedly if they could be of any assistance to our wounded. They wanted to know where Col. Colley and the guns were; and when we replied that he and his guns safe and sound having returned to camp during the night, they expressed great disgust and indignation, and immediately enquired how it was he managed to cross the river with his guns, as the river was so swollen and the current so rapid as to prevent (as they thought) any man crossing on foot. We replied that it was not so, and that, anyhow, the General and his guns were in the camp. This explained why no opposition was made to our retreat. The enemy thought the Ingogo was sufficiently swollen to prevent infantry crossing, and that consequently there was no occasion for them to oppose our retreat. However, they evidently intended to resume the attack next morning. They then inquired how many we had lost during the engagement. We replied that they could see for themselves, as the dead and wounded were all around them. Then looking

at the bodies of poor Greer and Mc Gregor, R.E., they asked if they were "cannon officers," and if there were any cannon officers alive on the field. We replied that one of the bodies was a cannon officer, and that there was one cannon officer wounded.* During this conversation some twenty or thirty more Boers arrived on the scene all fully armed, generally with Westley-Richards. In many cases they carried a bayonet strapped on to the waistbelt which was studded with small arm ammunition, as well as bandoliers full of ammunition. On arriving at the scene of so much bloodshed, the Boers silently dismounted, and, looking around, went to the dead horses, taking off the R.A. harness covers, wallets, straps, and buckles, and the nosebags which were full of corn. While picking up stray rounds of ammunition that were scattered all over the field they occasionally conversed with our wounded, always inquiring as to the whereabouts of Col. Colley, and if Sir Evelyn Wood was coming up soon. They seemed particularly anxious about Sir Theophilus Shepstone, wanting to know where he was, and expressing great anxiety to catch him, as they believed he was the cause of all that had happened.

About 8 a.m. we asked what was their intended action with reference to the killed and wounded, and they referred us to their General, who was reported to be about two miles off at a certain farm house. Upon this, the Rev. G. M. St. M. Ritchie, chaplain to the forces, (whose gallantry and distinguished conduct during this trying engagement, and through the night, was most marked) galloped away under a flag of truce to confer with the Dutch General, Smidt. Ritchie was met about a mile from camp by a party of Boers, who conducted him to their General, and in about half an hour the party arrived on the battle field. The Dutch General seemed much concerned at the scenes of terrible suffering around him, and asked if he could render any assistance; at the same time saying that we could do as we pleased with the dead, and that the wounded could, if necessary, go to Newcastle. Whereupon, all those not dangerously wounded were put into mule wagons that had been sent from camp by Sir G. Colley and taken in to Newcastle, conducted part of the way by Boer escorts. On arrival at Newcastle every possible medical assistance was offered them. Indeed, the medical organization at Newcastle was perfect.

The Dutch General remarked that everything on the battle field belonged to the Boers, and that all ammunition, rifles, &c., must be left on the field. With personal property, he said, he would not interfere. The rifles that we had to give up were partially disabled by extracting breech pins from the locks, breaking up the butts, &c.

Poor Wilkinson, Adjutant of the 3/60th Rifles, came with medical comforts for the wounded at daylight on the 9th, and was unfortunately drowned in re-crossing the river. He had accompanied Sir G. Colley on his night march to camp, and immediately on arrival there returned bravely to the battle field with succour for the wounded, running every risk of capture. Dr. McGaun's conduct throughout the engagement

* [This "cannon officer" was Lieut. Parsons himself.—*H.W.L.H.*]

and the night following was universally praised. He was always to be found in the fighting line attending the wounded in most exposed positions. The casualties in this action were very heavy; roughly, 150 killed and wounded out of a force of 500. The enemy's accuracy of fire was something marvellous, as was proved by the great percentage of killed and wounded, although the majority of our men were lying down and taking the best cover available. The number of men shot through the head was very remarkable, although the helmets had all been dyed a dark brown. The ground we occupied in the engagement was a kind of plateau (nowhere actually commanded), about 250 yds. long, with steep sides, particularly steep on the side away from the Ingogo River. The general nature of the ground was undulating, with an occasional deep valley that afforded excellent cover for the enemy, enabling them to mass their forces and leave their horses in comparative security. The stony nature of the ground much favored the Boers, whose plan of action was to send a few picked marksmen on foot up the side of the plateau in skirmishing order, pressing forward gradually, but surely. Eventually, each man seized a position behind a boulder or some such equally good cover, where he could at his ease pick off his man. Had we had a strong cavalry force to threaten their rear, and cut them off from their horses, the result would have been different. The only visible part of a Boer in action is his large broad brimmed hat, and the puff of smoke from his rifle.

Casualties in the R.A. :—14 horses out of 27; 16 men out of 27.

BRIEF NOTES

ON THE

9-PR. R. M. L. GUN OF 6 CWT.,

AND GENERAL EQUIPMENT.

Gun and Fittings.

Latterly it was found that the elevating gear worked unsatisfactorily, on account of the elevating screw having too great a play in the socket, so much so that great care in pulling the lanyard was requisite to prevent a strain being thrown on the breech of the gun when firing.

Carriage, &c.

The drag shoe gave trouble and occasionally snapped off from the chain, necessitating a turn round a spoke of the wheel with the drag-chain.

The wheels worked well, but the wedges of wood between the spokes

at the nave frequently came away. The lids of the limber boxes cracked badly owing to exposure and the variations of climate. Plating (·125-inch thick) of steel applied to the lids of the boxes would have been very useful, especially at the action of the Ingogo River, where the guns were under a smart infantry fire at short ranges. The lids would have afforded great protection to the gunners working at the limber, and the same remark applies to the lids of the axletree boxes.

The general service wagon was cumbersome and entirely useless for long marches over rough and hilly grounds. Two-wheel carts, peculiar to the country, drawn by mules, were very serviceable. One was required for each division.

7-pr. carriages.

The experience of the Zulu War proved that the axletree-arms of the 7-pr. R.M.L. are too weak: they invariably bent. The Kaffrarian pattern carriage, on the other hand, was cumbersome and in every way unsuited to the country. The low standing 7-pr. carriages with mules driven tandem, and two-wheeled carts carrying ammunition, were more economical and were found from experience to be just as serviceable. When going over rough ground these little carriages were steadied by the detachments with drag-ropes, one man to each rope was ample.

Ammunition.

The ammunition was satisfactory with the following exceptions :—

The case shot broke up in the axletree boxes after long marches over rough ground. The proportion of this projectile for rough warfare should be increased, as the firing of case shot had constantly to be resorted to in S. Africa, particularly at the Ingogo River engagement, where all the case shot was expended, and reversed shrapnel used as a substitute with very indifferent effect.

The lanyard hooks were too weak and frequently broke off.

The 15 sec. fuzes, used largely at the action at Laing's Nek, were found to be excellent; yet we constantly felt (especially at Laing's Nek) the want of a time fuze with some such adjustment that, even after the gun was loaded, the charge (if necessary) could be withdrawn and the fuze rapidly altered to suit another range. Sometimes, when the gun had been laid on a certain object and the fuze bored, orders would come for the guns to be at once laid on some other point, necessitating re-adjustment of the fuze, which, with our present fuzes, is generally impossible. Had we a fuze something on the principle of the old E time fuze, this difficulty might be met. The R.L. percussion fuzes were good with the 9-pr. R.M.L., but quite the reverse with the 7-pr. R.M.L., in which case prematures constantly occurred, the common shell with percussion fuzes sometimes bursting in the air. This was partly explained by the pellet and guard working forwards against the needle in flight, and revolving at a different rate to the body of the fuze. The tubes were satisfactory on the whole, although there were many

misfires. The (now) old practice of pricking the cartridge had to be resorted to with a very good result. It was found that tubes ought never to be kept in pouches for *any* time. Previous to an action a cylinder should be opened, all old tubes to be thrown away.

A good vent-server of some kind or other is a desideratum, especially when artillery are exposed to accurate rifle shooting as at the Ingogo River. This server would enable the No. 4 at the gun to be less exposed when the gun is being sponged out and the ammunition being rammed home. It is possible that a hollow expanding tube might be devised to answer this purpose.*

General equipment.

The camp kettle handles proved too weak, the weight had to be taken by improvised leather straps.

The nose bags for the off horses of the teams should both be carried on the off instead of one on the near and one on the off side; as when one of these nose bags was filled and carried on the near side, the necessary friction soon wore holes. Drivers valises were never carried but left at the base, two blankets and a waterproof sheet rolled up were carried in lieu on the off horses. In the event of a break down in the transport, which repeatedly occurred in S. Africa, the men were independent and bivouacked with their great coats, blankets and waterproof sheet, which in these cases were always with them. The gunners blankets, &c., were carried on the guns.

The mens' necessaries which are generally carried in the valises, were put into waterproof bags and carried with the transport wagons.

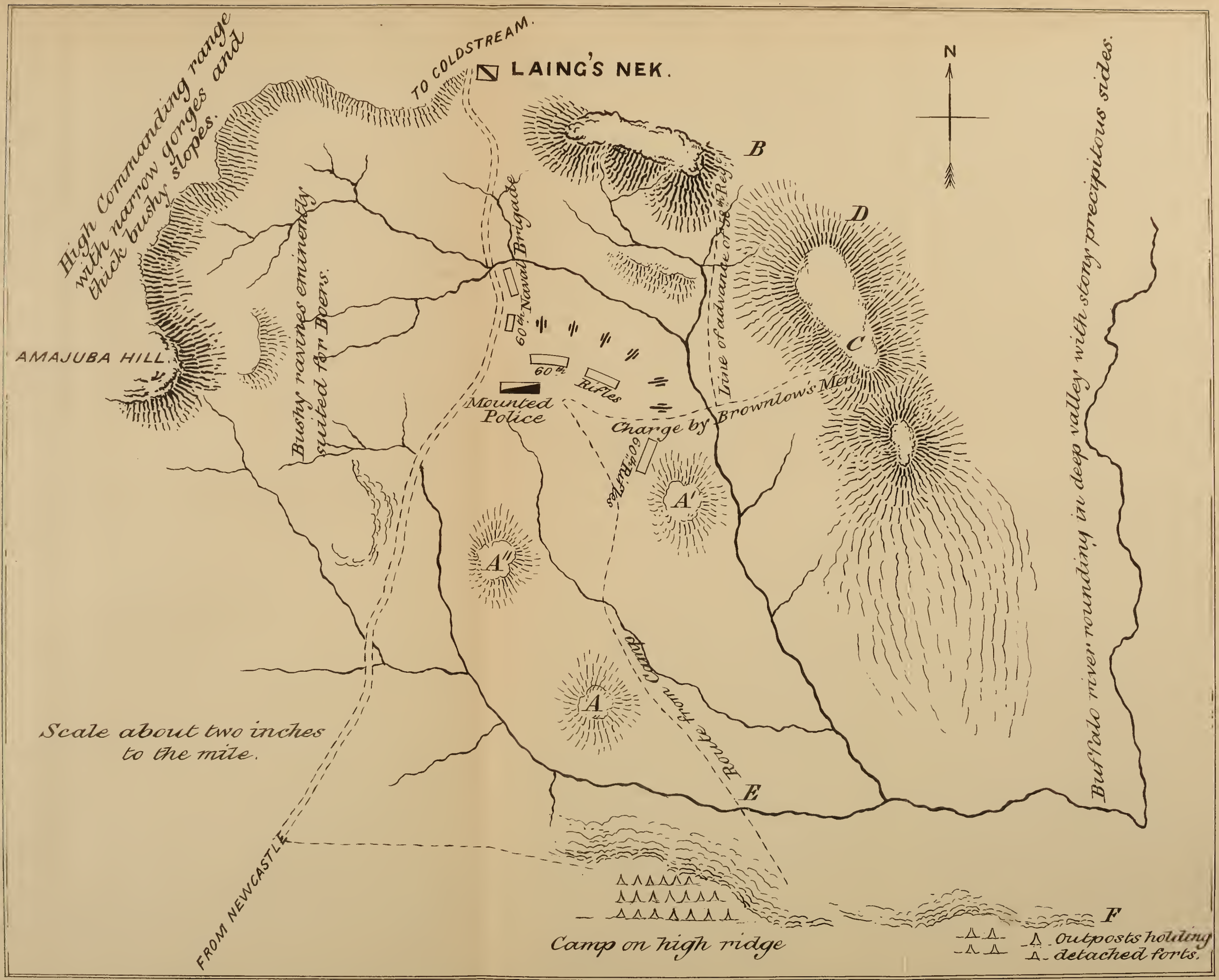
The present jack boot, issued to mounted corps, was found quite unsuitable for rough service in the field. An excellent and efficient substitute, although not so agreeable in appearance, would be an ankle boot with a leather legging. If the jack boot is to be retained, a slit ought to be cut over the instep, closed with a lace. We were compelled to adopt this practice, to enable the men to get on their boots when wet.

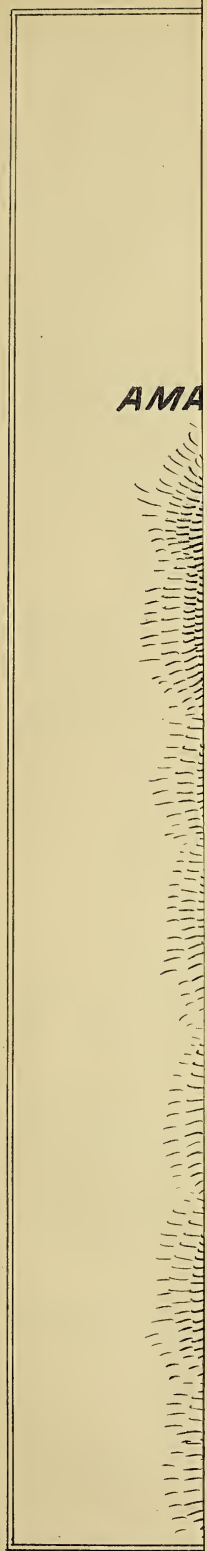
---

* [It will be remembered that Capt. N. P. Fowell, R.A., who wrote quite independently of Lieut. Parsons, came to exactly the same conclusion from his experience at Maiwand. See "Proceedings, R. A. I.," Vol. XI., No. 7, p. 518.—*H. W. L. H.*]

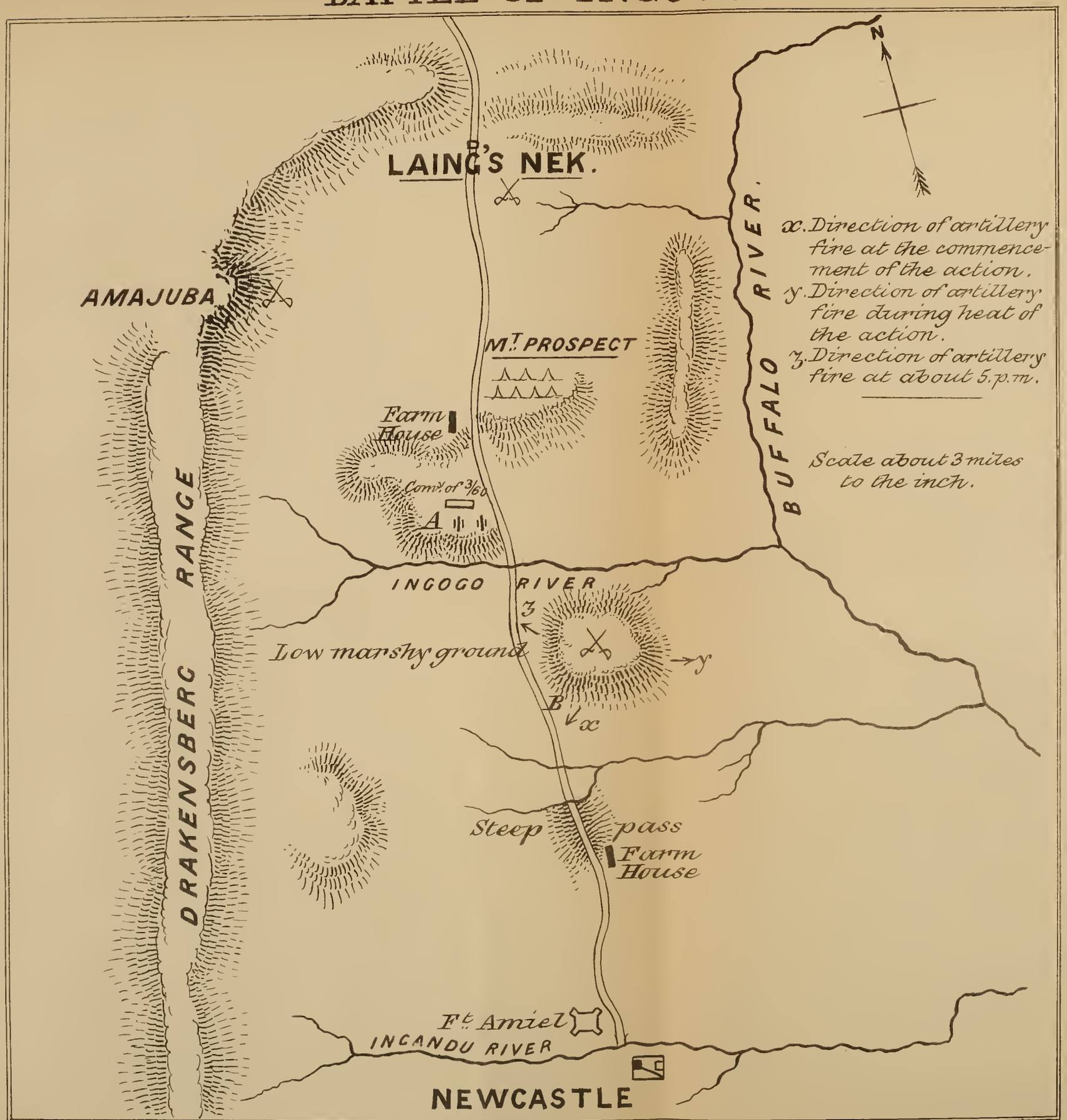
N
AMA
Buffalo river, rounding in deep valley with stony precipitous sides.
F
Outposts holding
detached forts.

BATTLE OF LAING'S NEK.




AMA

BATTLE OF INGOGO.



INDEX.

A.

PAGE

Adye, Lt.-Gen. Sir John, Remarks on Capt. C. Orde Browne's Report on Krupp's Meppen Experiments ... 283
Afghan armaments, Tabular statement of 144
Afghanistan, by Lt.-Col. Sidney Parry... 140
... A nation of soldiers ... *ibid.*
... Military stores presented by Indian Government *ibid.*
... Dost Mahomed's account of his gun making... ... 141
... composition of gunpowder 143
... equipment of troops ... *ibid.*
... Description of a special ammunition box used in 411
Africa, The French in, by Capt. T. J. Roch, R.A. 667
African War (South) of 1878-9, Professional notes by Lieut. Slade, R.A.... 253
Ali, Shere, armament of his army, by Lt.-Col. S. Parry, R.H.A. 140
Ammunition boxes, Observations on great weight of ... 269
... Description of a special box for carrying, used in Afghanistan ... 411
... Equipment of Artillery, in the field, by Col. W. J. Williams, R.H.A. ... 118
... Equipment of Artillery, in the field, by Maj. Nicholson, R.H.A. 309
... Expenditure of, by the Russian army in war of 1877-8 372
Annual General Meeting (Forty-fourth) Abstract of Proceedings ... 575
... report of clothing, Form of ... 73
... ... of R.A. Institution 1879-80 234
... ... 1880-81 575
Armament of Shere Ali's army, by Lt.-Col. S. Parry, R.H.A. 140
Armour, Necessity of, by Col. Inglis, R.E. 317
Armour bolts, Description of 323
... recommended for fixing armour plates ... ... *ibid.*
Armour-piercing projectiles up to 9-in. calibre, Notes on ... 477
... ... projectiles, reports of experiments in Russia and Holland ... 491
Armour plates, Fixing of ... 320, 323
... ... remarks on manufacture and resistance of ... 321
... ... wrought iron, Manufacture of 332
... ... reports on experiments in Russia and Holland 491
... ... Trials of, at Meppen ... 669
Armoured Defences, Notes on, by Col. Inglis, R.E. 317
... ... set up, Description of principal ... 334

PAGE

Armstrong, 100-ton gun accident ... 192
... ... conclusions of Italian commission 198
Artillery, Use of, as a pivot on occasions of flank movements 29
... Proposed limber system for field 113
... Foot, Addendum to the drill regulations of, Berlin, 1880 ... 469
... Résumé of the report of the conference held in Vienna on the best method of employing 643
... Increasing importance of light artillery, by Maj. W. B. E. Ellis, R.A. 117
... Note on the ammunition equipment of 118
... Table of duties required of field artillery and projectiles best adapted for 313
... The training of "Pointeurs" for 673
... in the field, Ammunition and equipment of 549
... Field, Equipment of 309
... ... Attack of entrenchments by, by Maj. Kemmis, R.A. 215
... ... Proposed limber system for, by Maj. W. B. E. Ellis, R.A. 199
... in the field, Rank, post and duty of an officer commanding 357
... Field, in England, French conclusions respecting 428
... at Maiwand, Note on the service of... 518
... Garrison, Organization and employment of 389
... Horse, weight of gun ... 566
... ... and Field, Adoption of revolver for, in Holland 345
... and Engineer Journal, from the Italian (Extracts) ... 538
... Field, Austrian, notes on service practice 653
... Greek, Decree fixing the peace and war establishment of the army of Greece 645
... Horse, Holland, Trials of steel-bronze guns for 665
... batteries, Italian, Constitution of 371
... Italian, Re-organization of ... 417
... Portuguese, Description of ... 661
... Russian field, in the war of 1877-78 292
... Russian, Rumoured re-organization of 371
... Russian, in the Shipka Pass... 523
Astronomical observations, Notes on, by Major E. S. Gordon, R.A. 539

PAGE

Attack of entrenchments by field artillery, as a question of tactics of the unit, by Maj. Kemmis, R.A. 223
Attack on entrenchments by field artillery, by Maj. Kemmis, R.A. 215
Austrian, trial of a repeating rifle ... 522
... extracts from Austrian artillery journal 643
... field artillery service practice, Notes on 653
... mountain artillery in Bosnian campaign ... 24
... ... organization 24
... ... equipment 25
... ... mobilization *ibid.*
... ... distribution *ibid.*
... ... tactics ... 26

B.

Bainbridge, E., Capt. R.A. Practice with the Nordenfelt machine gun 511
... ... Description of the 1-inch torpedo battery gun ... 515
Balance sheet of a garrison battery, Form of... 55
Banjaluka, Order of march on 27
Battery, garrison, Office work of a ... 47
Battle of Ulundi 153
Beckerhinn, Capt., French field guns, with a table of the field guns of the principal European Powers 159
Boguslawski, Lt.-Col. Infantry fire in fortress warfare... 427
Boiler plates, Experiments with shields composed of 319
Bond, R. M., Lieut. R.A. (translation) infantry fire in fortress warfare ... 427
Bolan Pass, Passage of, by heavy field or elephant battery 247
Bosnian campaign, Austrian mountain artillery in 24
Boys, Admiral H., Remarks on Capt. C. Orde Browne's paper on Krupp's Meppen experiments 286
Brown, Lt. Col. J. T. B. An account of the march of Lord Chelmsford's column to Ulundi 146
... An account of the march of Lord Chelmsford's column. Battle of Ulundi 153
Browne, Capt. C. Orde. Lecture on recent experiments regarding the bursting of heavy guns ... 177
... Krupp's Meppen experiments of 1879... 271
... Remarks of Lt.-Gen. Sir John Adye, on paper read by... ... 283
... ... Admiral H. Boys, on paper read by 286
Bullock teams for conveyance of guns, suggested 37
Bursting of heavy guns, Experiments in, by Capt. C. Orde Browne 177

C.

PAGE

Campaigning and exploring, List of necessaries and luxuries, by Capt. Fraser, R.E. 619
Carbine, repeating, Issue of, to the Rifle Battalion of the Guard, in Germany 416
Carey, W., Lt.-Col. R.A. The effect of shell on mud walls 624
Carré, G. T., Capt. R.A. Account of the Zaimukht Expedition under Brig.-Gen. Tytler 399
Carriage of ammunition during war in Afghanistan, description of a special box 411
Cartridges, Linen, in Italy 538
Case shot, Remarks on 310
Casemate shield of 1870, Experiments ... with... 324
... shields, description of plates 337
... ... for guns mounted on turntables 337
Cash book of a garrison battery, Form of 54
Cast-iron (chilled) projectiles, Adoption of 320
Chelmsford, Lord. March to Ulundi ... 146
Cheswedjuma, Occupation of 267
Chilled cast-iron armour, Experiments with 327, 331
... ... Manufacture of... ... 333
... ... projectiles, Adoption of 320
Clinometers, Weakness of 261
Clothing Regulations 60
... Demands for 61
... Great coats and capes 69
... Annual report of 73
... chest, Form of demand for ... 80
... Compensation for unused ... 80
... Majors' responsibility with respect to 81
... account, How to keep 83
... new, How to be accounted for 84
... &c., made away with, Punishment for 90
... repair of, Allowances for ... 100
... Foreign stations. Regulations 96
Coast batteries to be constructed of masonry... 320
Coil washer, Description of 324
Collingwood, C., Maj. R.A. March of 5/11 heavy field, or elephant, battery from Morar to Kandahar 245
Common shell, Description of 310
... ... new pattern in Italy ... 538
Compass variations, Observations on, by Maj. E. S. Gordon, R.A. 539
Compensation to men for unused clothing 80
Compound plates, Manufacture of ... 333
Cox, F. E., Col. R.E. Complete list of personal and official equipment for special service 613
Crawford, G. A., Maj. R.A. Report on experimental practice on the walls of Kandahar 629
Crosthwaite, C., Maj. R.A. The effect of shell on mud walls 627
Cundill, J. P., Capt. R.A Explanatory notes on Prof. Greenhill's paper "on the rotation required for the stability of an elongated projectile" 103
... Notes on experiments with armour-piercing projectiles up to 9-in. calibre 477

D.

PAGE

Dalton, J. C., Capt. R.A. Preface to Spanish article on the Russian field artillery in the war of 1877-78 291-22
... (Translation.) Description of Portuguese artillery 661
Danube. Passage of the Russian field artillery, 1877-78 293
de Broca, M. P., Telescope invented by 665
de Cossigny, Col. Notes on the laying of guns by means of a telescope ... 403
Defences, armoured, Notes on. Col. Inglis, R.E. 317
Demands for clothing, how to be made 61
Denis-de-Vitre, W., Brig.-Gen. R.A. The effect of shell on mud walls 623
Derivation, or drift of elongated rifled projectiles, by Prof. Greenhill ... 124
Detonating compound, dynamoge, Trials with 522
Discharged men. Return of clothes ... 77
Dolni Fulza, Artillery battle at... ... 28
Dover Pier, Turret on, Description of ... 341
Downing, D.F., Lieut. R.A. Explaining a telescopic sight for Field Guns ... 20
Drayson, A. W., Col. R.A. Remarks on the Weldon Range-Finder 363
Drift, or Derivation of elongated rifled projectiles, by Professor Greenhill ... 124
Drill Regulation of Foot Artillery. Berlin, 1880 469
Dunlop, H. C., Lieut. R.A. Description of a range-finder proposed by Capt. F. Roberts, R.A. ... 365
... ... (translation). The training of "Pointeurs" for Artillery 673
Dutch trials of competitive projectiles 507
Duties of Subaltern Officers. Lieut. A. M. Murray, R.H.A. 373
Duty, Rank, and Post of an Officer commanding R.A. in the field ... 357
Dynamoge. Detonating compound. Trials with 522

E.

Edwards, E. G., Lieut. R.A. Field range-finding 202
... ... Range-finders ... 209
... ... Remarks by Major J. B. Richardson, R.A. 355
Ekowe. The March to, and Defence of 451
Elementary Squad Drill in the Swiss Army. Notes on 420
Elephant Battery, March of, from Morar to Kandahar, by Major C. Collingwood, R.A. 245
Elephants as carriers of mountain guns 32-37
... tenderness of their feet ... 33
Elongated Projectiles, by Capt. J. P. Cundill, R.A. Notes on 103
... ... Professor Greenhill. Rotation required for stability of ... 119
... ... Professor Greenhill. Derivation or Drift of 124

PAGE

Ellis, C. H. Fairfax, Maj. R.A. Experiments carried out by Herr Krupp at Meppen 669
Ellis, W. B. E., Maj. R.A. Proposed limber system for field artillery 113, 199
Enemy's works, Means of discovering ... 392
... ... Operations after discovery 394
Engineer and Artillery Journal, from the Italian 538
Entrenchments, Attack of, by Field Artillery, by Major W. Kemmis, R.A. (R.A.I. prize essay, 1880) 215
Equipment, Brief notes on, by Lieut. C. S. B. Parsons, R.H.A. 689
... Regulations 96
... of Artillery in the Field, by Col. W. J. Williams, R.A. 118
... of field artillery, by Capt. J. R. J. Jocelyn, R.A. (R.A.I. prize essay, 1881) 549
... for special service, by Col. Cox, R.E. 613
... of Austrian Mountain Artillery 25
Escorts, Importance and duty of ... 305
Expedition, Zaimukht, Account of, by Capt. G. T. Carré, R.A. 399
Expenditure of ammunition by the Russian Army in war of 1877-78 ... 372
Experiments regarding the bursting of heavy guns, Lecture by Capt. Orde Browne ... 177
... with armour-piercing projectiles up to 9-in. calibre, Notes on 477
Explorations. Observations on fixing positions for Astronomical Observations 539

F.

Fersman, Lt.-Gen. The organization and employment of garrison artillery ... 389
Field artillery, Equipment of 549
... ... Adoption of revolver for, in Holland 345
... ... Proposed limber system for 113, 199
... ... Attack by, of entrenchments, by Maj. W. Kemmis, R.A. ... 215
... ... Table of duties required and projectiles best adapted for 313
... ... in England, French conclusions respecting ... 428
... ... Austrian, Notes on service practice 653
... ... Russian, in the war of 1877-8 292
... battery gun, Weight of 566
... glasses, Remarks on, by Capt. Politovski 298
... guns, Telescopic sight for ... 20
... ... French, by Capt. Beckerhinn, with table of the field guns of the principal European Powers ... 159
... range finding, by Lieut. E. G. Edwards, R.A. 202

PAGE

Fletcher, A. F., Capt. R.A. Description of a special box for the carriage of ammunition, used in Afghanistan ... 411
Foot artillery, Addendum to the drill regulations of, Berlin, 1880 469
Fort, stone-wall, at Camp Thull, Description of 672
... Cunningham, Bermuda, Description of 338
Fortress warfare, Infantry fire in ... 427
Fowell, N. P., Capt. R.A. Note on the service of the artillery at Maiwand ... 518
Fraser, T., Bt.-Maj. R.E., Shooting properties of small arms in use in Europe. (Translation) ... 1
... List of necessaries and luxuries for campaigning and exploring 619
French in Africa, by Capt. T. J. Roch, R.A. 667
... battery, Peace establishment of 161
... conclusions respecting field artillery in England 428
... field guns, by Capt. Beckerhinn 159
Fuze, Italian percussion, for field and mountain guns 343

G.

Gaudamak, Battle fought at 362
Gardner battery, Plate representing ... 572
... gun, mounted on tripod, Plate representing ... ... *ibid.*
Garrison artillery, Organization and employment of 389
... battery, Office work of ... 47
Gâvre, Experiments at, with a 35-ton Whitworth gun 326
... French experiments at, with steel plates 330
German Imperial manœuvres, 1880 ... 429
... prismatic gunpowder, Best results from 467
Germany, Issue of a repeating rifle to the Guards 371
... Issue of a repeating carbine in 416
... Medical service in the German army 650
... The fortifications of Kœnigsberg and Kœnigstein ... 416
Ghaziaband Pass, Passage of, by heavy field, or elephant battery 250
Gold Medal Prize Essay of 1880, by Maj. Kemmis, R.A. ... 215
... ... Prize Essay of 1881, by Capt. J. R. J. Jocelyn, R.A. 549
Goodenough, W. H., Col. R.A. Notes on the Austrian field artillery service practice 653
Gordon, S. E., Maj.-Gen. Remarks on Capt. C. Orde Browne's report on Krupp's Meppen experiments ... 285
Gordon, E. S., Maj., R.A. Observations on fixing positions for observations in explorations 539
Graham, C. S., Capt. R.A. Note on elementary squad drill in the Swiss army 420
Greece, Decree fixing the peace and war establishments of the artillery of the army of 645

PAGE

Greenhill, Professor A. G., on the rotation required for the stability of an elongated projectile ... 119
... on the derivation, or drift, of elongated rifled projectiles... 124
... on the motion of a projectile in a resisting medium ... 131
... explanatory notes, on a paper by Capt. J. P. Cundhill, R.A. 103
... on the motion of a projectile in a resisting medium ... 589
Grierson, J. M., Lieut. R.A. Austrian mountain artillery in Bosnian campaign, 1878 24
... Précis of contents of the "Organ der Militär-Wissenschaftlichen Vereine 413
... (translation) Diary of Russian artilleryman in the Shipka Pass 523
... Translation of Extracts from "Russian Artillery Journal" 637
... Extracts from the "Organ der Militär Wissenschaftlichen-Vereine." 649
Gun, 9-pr. of 6 cwt., Notes on, by Lieut. Parsons, R.H.A. 687
... Hotchkiss revolver. Comparative trials 519
... ... Plates representing ... 572
... jointed, Description of a 7-pr. R. M. L. 401
... ... Description of stone-wall fort thrown up for, at Camp Thull 672
... Nordenfelt, machine, Practice with 511
... torpedo, battery, 1-in. Description of 515
Gunnery, The attack of field entrenchments as a question of... 215
Gunpowder made in Afghanistan, component parts 143
... An improved shape for moulding. German prismatic ... 467
Guns, Perforating power of 325
... Powder charges for 326
... Notes on the laying of, by means of a telescope 403
... Experiments regarding the bursting of heavy, lecture by Capt. C. Orde Browne 177
... Trajectories of the 9-pr., 13-pr., and 16-pr. M. L. R. 421

H.

Han Belálovac, result of turning movement on 26
... ... Order of advance on ... 20
Helmets, Form of demand for 71
"Hercules" target, Composition of ... 320
Holland, Adoption of revolver for horse and field artillery in... ... 345
... Reports on experiments with armour-piercing projectiles... 503
... Dutch trials of competitive projectiles 507
... New Krupp gun, 7.5^{cm} (3-in.) 637
... War budget of 1881 647

PAGE

Holland, Trial of steel bronze guns for horse artillery 665
Horse artillery, Adoption of revolver for, in Holland 665
... Résumé of the report of the conference held in Vienna on the best method of employing 643
... gun, Weight of... ... 566
Horse Sand and No Man's Land Fort, Description of, and Plates ... 339
Hotchkiss revolver gun, comparative trials 519
... Plates representing 572
Hotham, J., Lieut. R.H.A. Description of a Veterinary field companion ... 599

I.

Indian frontier service, Mountain guns for 32
Indra, Lieut. Austrian Artillery, shooting properties of small arms in use in Europe 1
Infantry fire in fortress warfare ... 427
"Inflexible," 9-inch compound plates adopted for the turrets of H.M.S. ... 330
Inglis, Col. R.E. Notes on armoured defences 317
Ingogo, Battle of 682
Iron defences, experimental stages ... 318
... plates, targets of, Experiments against 326, 327
Italian percussion fuze (1879) for field and mountain guns 343
Italy, horse artillery batteries, how constituted 371
... Re-organization of artillery ... 417
... Vetterli rifle, New sight for ... 346

J.

Jeni Saari, Account of the Russian artillery attack on 294
Jocelyn, J. R. J., Capt. R.A. The equipment of field artillery (R. A. I. Prize Essay, 1881) 549
Johnson, R. F., Lieut. R.A. Observations on Lieut. Murray's article "Subaltern officers" 605
Jointed gun, 7-pr. R. M. L., Description of 401
... Description of small stone-wall fort thrown up for, at Camp Thull 672

K.

Kambula, Battle of, Effects of artillery fire 259
Kandahar, March of 5/11 R.A. from Morar to, by Maj. C. Collingwood, R.A. 245
... The effect of shell on the mud walls of 623
... Results of breaching practice at 625
... Report on experimental practice at 627
Karabunar, Account of attack on ... 300

PAGE

Kemmis, Maj., The attack of entrenchments by field artillery (R.A.I. Prize Essay, 1880) 215
... The attack of entrenchments as a question of tactics of the unit 223
Khonoma, Account of attack on ... 264
Kœnigsberg, The fortifications of ... 416
Kœnigstein, The fortifications of ... 416
Kremenac, Failure of attack on ... 28
... Order of advance on ... 29
Krupp gun accident, The 191
Krupp's Meppen experiments, by Capt. C. Orde Browne, ... 271, 669
... Remarks on, by Lt. Gen. Sir John Adye ... 283
Admiral H. Boys 286
... screw mountain gun, Practice with 637
Kwaja Pass, Passage of, by heavy field, or elephant battery 250

L.

Laing's Nek, Battle of 677
Ledger, Time for closing... ... 90, 102
Leggings, Form of demand for... ... 73
Limber system for field artillery, Advantages of, for service in distant and sterile countries 113
... ... applicable to heavier guns 114
... ... Comparison of weights of gunners and rounds proposed to be carried, and present system ... 115
... ... proposed for field artillery 199
Linen cartridges in Italy 538
Lloyd, W. N., Lieut. R.H.A. The march to, and defence of, Ekowe 451
Löwe, system of repeating rifle, result of experiments... 371
Luxuries and necessaries for campaigning and exploring, by Capt. Fraser, R.E. 619

M.

M'Clintock, W., Capt., R.A. Reports on experiments with armour-piercing projectiles in Russia and Holland ... 491
MacMahon, P. A., Lieut. R.A. Trajectories of the 9-pr., 13-pr., and 16-pr. M.L.R. guns 421
Machine gun, Nordenfelt, Practice with 511
Maglai, Account of engagement at ... 26
... Difficulties in advance on ... 30
Maiwand, Note on the service of the artillery at 518
Mansel, A., Lieut. R.A. Mountain guns in the Naga Hills 263
Manœuvres, German Imperial, in 1880 429
Mantlets, Use and description of ... 341
March of Lord Chelmsford's column to Ulundi 146
March of 5/11 heavy field or elephant battery, from Morar to Kandahar, by Maj. Collingwood, R.A. 245
Martini-Henry, Angle of elevation for... 6
... Marked superiority of... 7
... Muzzle velocity of ... 10

PAGE

Mazel, Mons. G., Tactics of the three arms of the service 639
Meppen, Experiments at, on Krupp's matériel ... 271
... ... carried out at, by Herr Krupp 669
... Remarks on, by Lt.-Gen. Sir ... ... John Adye ... 283
... ... Admiral H. Boys 286
Mitrailleuse, Nordenfelt, comparative trials 519
"Mittheilungen über Gegestände" Contents of, by Capt. G. C. Wynne, R.A. 418
Mobilization of Austrian mountain artillery 25
Morar to Kandahar, Description of march of 5/11 heavy field or elephant battery 245
Motion of a projectile in a resisting medium 589
Mould for gunpowder, German prismatic, An improved shape for ... 467
Mountain artillery (Austrian) in Bosnian campaign ... 24
... ... suggested without wheels 30
Mountain guns for Indian frontier service 32
... ... in the Naga Hills, by Lieut. A. Mansel, R.A. 263
... ... Italian percussion fuze (1879) for 343
Mud walls, The effect of shell on ... 623
Murray, A. M., Lieut. R.H.A. The duties of Subaltern officers 373
Murray, Lieut. J. Wolfe, R.A. Extracts from the Russian Small Arms Magazine 603
Muzzle-loading gun, 13-pr., Notes on ... 163
... ... Results of practice 169
... velocity, Comparison of... ... 1

N.

Naga Hills, Mountain guns in the, by Lieut. A. Mansel, R.A. 263
Nagas, Notes on 270
Necessaries and luxuries for campaigning and exploring, by Capt. Fraser, R.E. 619
New clothing, how to be accounted for 84
Nicholson, S. J., Maj. R.H.A. Short notes on the 13-pr. M.L. gun... 163
... Ammunition equipment of artillery in the field ... 309
Noble, A., Capt. Diagram of "Thunderer" gun 179
Nolan's system of range-finding, Observations on 203
Nominal roll, Care required in keeping 87
Nordenfelt machine gun, Practice with 511
... mitrailleuse and the Hotchkiss revolver gun, comparative trials 519
Novi Bazar, Account of occupation of ... 24
Noviseher, Engagement at 26

O.

Office work of a garrison battery ... 47
Official equipment for special service, by Col. Cox, R.E. 613

PAGE

"Organ der Militär-Wissenschaftlichen Vereine," Précis of contents 413
Organization and employment of garrison artillery (Russian prize essay) ... 389

P.

Palliser gun, Experiments with ... 186
Parry, Sidney, Lt.-Col. R.H.A. The armament of Shere Ali's army ... 140
Parsons, C. S. B., Lieut. R.H.A. The battles of Laing's Nek and Ingogo, with notes on 9-pr. gun of 6 cwt. and general equipment 677
Pay of a garrison battery, regulations ... 48
... list, vouchers 53
Percussion fuze, Italian, for field and mountain guns 343
Personal equipment for special service, by Col. Cox 613
Petry, F. J. Trials with his detonating compound, dynamoge 522
Phillips, Lieut. T. V. W. Description of small stone-wall fort, thrown up for two 7-pr. R.M.L. jointed guns at Camp Thull 672
Phipps, Maj. R. Further notes on the office work of a garrison battery ... 47
Plate-upon-plate target, Experiments with 35-ton gun at a 324
Plymouth Breakwater Fort, Experiments against a casement representing 323
... ... Description of 338
"Pointeurs," the training of, for artillery 673
Portland Breakwater Fort, Description of, and plates 338
Portuguese artillery, Description of ... 661
Post, rank and duty of an officer commanding R.A. in the field 357
Prize essay. Gold medal of 1880 ... 215
... ... 1881 ... 549
Projectile in a resisting medium, Motion of, Prof. Greenhill 589
Projectiles, elongated, Notes on. Capt. Cundill ... 103
... ... Rotation required for stability of. Prof. Greenhill 119
... ... Derivation or drift of. Prof. Greenhill 124
Prussian mode of indirect laying of guns 660

R.

Range-finder, Weldon's, by Maj. Richardson, R.A. ... 41, 347
... Remarks on, by Lieut. Edwards, R,A.... ... 212
... Remarks on, by Col. Drayson 363
... Remarks on, by Lieut. Russell, U.S.A. 631
... Description of a proposed, by Capt. F. Roberts, R.A. 365
Range-finders, Lieut. Edwards, R.A. 209

PAGE

Range-finding. Observations on Nolan's system of 203
... Field. Lieut. Edwards, R.A. 202
... School. Lieut. Edwards, R.A. 208
Range-table, compiled by Maj. Tremlett, R.A., and used in South African War 262
Rank, post, and duty of an officer commanding R.A. in the field 357
Recruits, Clothing for 76
Regimental necessaries, Form of demand for 74
Repairs to clothing, Allowances for ... 100
Repeating carbine, Issue of, to the Rifle Battalion of the Guard, in Germany 416
Repeating rifle, Issue of, in Germany, to the Guards 371
... ... Trial of a, in Austria 522
Revolver, adopted for horse and field artillery in Holland 345
Revolver gun, Hotchkiss. Comparative trials ... 519
... ... Plates representing ... 572
Richardson, J. B. Maj. R.A. The Weldon range-finder ... 41
... Letter on the Weldon range-finder 347
Rifle, repeating, Trial of a, in Austria ... 522
Rifled guns, Early experiments with ... 319
Rifled ordnance, Early experiments with 319
Roberts, F., Capt. R.A. Description of a proposed range-finder 365
Roch, T. J., Capt. R.A. The French in Africa ... 667
... ... Tactics of the three arms of the service 639
Rogelje, Capture of 28
Roll, Care required in keeping 87
Russell, A. H., Lieut. U.S.A. Remarks on the Weldon range-finder 631
Russia, Ammunition expended by the army of, in war of 1877-78 ... 372
... Mode of preserving guns from rust 603
... New rules for competitive practice 637
... Organization of the Russian reserve troop 649
... Reports on experiments with armour-piercing projectile 491, 492, 496
... Rumoured re-organization of Russian field artillery ... 371
Russian artillery. Design for a new gun 496
... ... Result of deliberations respecting guns ... ... *ibid.*
... ... in the Shipka Pass... 523
Russian field artillery in the war of 1877-78 292
Russian Small-arm Magazine, Extracts from 603
Russo-Turkish war, Remarks on ... 650
Rust, Russian mode of preserving guns from 603

S.

Schkarewitsch, Lt.-Col. The organization and employment of garrison artillery 389

PAGE

School of range-finding, suggested by Lieut. Edwards, R.A. 208
Sea Forts, decision to protect with walls of iron 320
... Description of, and plates for 338
... Turrets on 341
Sea kit necessaries, Form of demand for 76
Secocœni, Campaign against 254
Serajevo, Account of capture of ... 28
Shell on mud walls, Effect of 623
Shells, Relative value of, in battle, by Col. W. J. Williams, R.A. 118
Shere Ali's army, Armament of, by Lt.-Col. S. Parry, R.H.A. 140
Shergadra Heights, Account of attack on 32
... ... Withdrawal from ... 36
... ... ammunition expended *ibid.*
Sherpur fortress, Description of... ... 143
Shields of boiler plates, Result of experiments with ... 319
... rolled iron do do *ibid.*
Shipka Pass, Diary of a Russian artillery-man in the 523
Ships' decks, Experiments with shot and shell upon 325
Ships' targets, Early experiments with... 319
Shoeburyness, Masonry casements at ... 320
Shrapnel, Description of... 311
Shrapnel fire, Effects of, considered, by Col. W. J. Williams, R.A. 118
Siege attack, Time to arm against ... 390
Sight for Vetterli rifle in Italy 346
Slade, F. G., Lieut. R.A. Professional notes made during South African war, 1878-9 253
Sladen, Maj. R.A. Remarks on Capt. C. Orde Browne's report on Krupp's Meppen experiments 287
Small arms, Shooting properties of ... 1
Smith, W. O., Capt. R.A. Report of experimental practice on the walls of Kandahar 627
Smythe, W. J., General. Remarks on Capt. C. Orde Browne's report of Krupp's Meppen experiments ... 289
South African war of 1878-9, Professional notes by Lieut. Slade, R.A. ... 253
Spitbank Fort, Description of 339
Squad drill in the Swiss army, Notes on 420
Steel-bronze guns, Holland, Trials of ... 665
Steel gun, Krupp's, Experiments on ... 271
Steel plates, Result of early trials of ... 321
... Italian experiments with ... 329
Steel and compound armour targets, Experiments with 328
Stock book, for daily record of transactions 91
Stone-wall fort at Camp Thull, Description of 672
Stoney, F. S., Maj. R.A. Remarks on Capt. C. Orde Browne's report on Krupp's Meppen experiments ... 287
Subaltern officers, Duties of, by Lieut. A. M. Murray, R.H.A. 373
... Observations on, by Lieut. R. F. Johnson, R.A. 605
Supply and transport of light artillery ammunition, by Major W. B. E. Ellis, R.A. 199
Surplus clothing, Remarks on 73
Swiss army, Elementary squad drill in the 420

PAGE

Szapary's advance on Bosnia—Order of march 27
... Retreat, how covered ... 29
... ... cause of failure ... 30

T.

Tactics of the Unit, The attack of field entrenchments as a question of 223
... of the Mass, The attack of field entrenchments, as a question of 228
... of the Three Arms of the service, by Capt. T. J. Roch R.A. ... 639
Targets, representing ships' sides, Experiments with 319
Taylor, M. Le Fer, Col. R.A. Remarks on Capt. C. Orde Browne's report on Krupp's Meppen experiments 288
... on Dutch trials of competitive projectiles 507
Telescope for field batteries, Necessity of 298
... Notes on the laying of guns by means of a 403
... Instructions in the use of ... 405
... invented by M. P. de Broca... 665
... sight for field guns 20
"Thunderer" gun accident, Cause of ... 177
... ... Diagram of 179
... gun experiments... ... 180
Tolyana's stronghold, Attack on ... 255
Torpedo battery gun, 1-in., Description of... 515
Trajectory flatness, A high muzzle velocity required for 1-10
... Time of flight ... 5
Trajectories of the 9-pr., 13-pr., and 16-pr. M. L. R. guns 421
Transfers, General rules 78
Transport and supply of light artillery ammunition, by Major W. B. E. Ellis, R.A. 199
Tremlett, Maj., Range table compiled by and used in South African war ... 262
Tungin Nek, Action of 259
Turner, A. E., Capt. R.A. Adoption of a revolver for horse and field artillery in Holland 345
... German imperial manœuvres in 1880 429
... Translations of articles :—
... Germany, Issue of a repeating rifle... 371
... Italy, Horse artillery batteries ... ... *ibid.*
... Russia, Field artillery ... *ibid.*
... ... Expenditure of ammunition in the war of 1877–8 372
... Issue of a repeating carbine in Germany 416
... Comparative trials of the Nordenfelt mitrailleuse, and the Hotchkiss revolver gun ... 519
... The Artillery and Engineer journal, from the Italian ... 538
... Résumé of the report of the conference held in Vienna on the best method of employing horse artillery 643
... Peace and war establishments of the artillery of the Greek army 645
Turntables, Casemate shields for guns mounted on 337

PAGE

Turret trials. Cupola of "Trusty" ... 325
... ... Turrets of "Royal Sovereign" ... ... *ibid.*
... ... Turrets of "Glatton" ... *ibid.*
... on Dover pier, Description of ... 341
Tweedie, M. Lt.-Col. R.A. An improved shape for moulding gunpowder ... 467
Tytler, Brig.-Gen. J. A., V.C., The Zaimukht expedition under 399

U.

Ulundi, An account of the march of Lord Chelmsford's column to ... 146
... Battle of 153
... . . Effects of artillery fire 260

V.

Van Straubenzee, Maj. R.A. Prussian mode of indirect laying of guns ... 660
Veterinary field companion, Description of a 599
Vetterli rifle, New sight for, in Italy ... 346
Vienna, Résumé of the report of the conference held in, on the best method of employing horse artillery 643
Vranduk, Order of march on 27
... Order for advance on ... 29

W.

Walsh, E., Capt. R.A. Mountain guns for Indian frontier service ... 32
... (Translation.) Notes on the laying of guns by means of a telescope 403
"Warrior" target, Composition, &c., of 319
Watkin's system of range-finding, Observations on 203
Weldon range-finder, by Maj. Richardson, R.A. 41
... ... Remarks on, by Lieut. Edwards, R.A. 212
... ... Letter from Maj. Richardson, R.A., on... 347
... ... Remarks on, by Col. Drayson, R.A. ... 363
... ... Remarks on, by Lieut. Russell, R.A. 631
Werndl rifle, Angles of elevation for ... 3–5
Whitworth, 35-ton gun. Experiments with, at Gâvre 326
Whitworth, Sir J. Armour plate ... 331
Williams, W. J., Col. R.A. Note on the ammunition equipment of artillery in the field ... 118
... On the rank, post, and duty of an officer commanding R.A. in the field 357
Wool, Failure of, to resist cannon shots 319
Wynne, G. C., Capt. R.A. Translation of articles on Italian percussion fuze (1879) for field and mountain guns 343
... Contents of the "Mittheilungen über Gegestände" 418

Z.

Zaimukht expedition, under Brig.-Gen. J. A. Tytler, VC. 399
Zawa, Account of capture of ... ... *ibid.*
Zepce, Order of advance on ... 26, 28

"ORGAN DER MILITÄR-WISSENTSCHAFTLICHEN VEREINE,"

PART I., 1880.

TRANSLATED BY

LIEUT. J. M. GRIERSON, R.A.

This number opens with a retrospect of the military events in Austria in 1879, the principal of which was the occupation of the Sandjak of Novi Bazar by the 1st Division of the Imperial army. As this was effected without fighting, it offers little of interest.

A paper on the changes in the map of Europe since 1815 by Dr. Neumann gives a summary of the conditions of the various treaties in which our century, and particularly the latter part of it, has been so fecund.

This is followed by a most interesting paper on the tactical uses of fire from under cover (at unseen objects). The author, Lieut. Mirkovic, of the 11th Artillery, first draws attention to the enormous losses in men and horses suffered by artillery in coming into action on ground swept by the enemy's fire, and proposes that, instead of unlimbering just behind the crest of a ridge, the guns should be brought into action some way down the rear slope, and the observation and correction of the firing conducted by mounted men, or by men standing on the limbers. An auxiliary object on the crest of the hill (as in mortar practice) could be used to assist in laying, which would have to be performed by means of a clinometer. He contends that this procedure would be of the greatest use when guns are moved to the "second artillery position" (which Hoffbauer lays down as at 600 paces), to afford moral and material support to the infantry, and also on many occasions when a large number of guns are massed together; as in many places a good position cannot be found on or near the crest of a ridge in the general line of the mass. The loss of accuracy he contends to be more than compensated for by the diminution of the losses in men and horses which so powerfully affect the mobility—that great desideratum of modern field artillery. The rest of the paper is devoted to the same species of firing from small-arms.

Lieut. Kestranek, 19th Regt., contributes a paper on the disarming of insurgent villages, in which our own troops ought to have had considerable experience in Afghanistan. In the case of districts which have not yet been traversed by troops, he recommends the use of mixed columns of all arms (the cavalry being only used as orderlies).

Every opportunity should be taken of improving the communications and opening up the country as the column marches, both with a view to the return march and to subsequent operations; and for this purpose as many pioneers as possible should accompany the troops, marching at the head of the column. Disarming should be considered as a distinctly military operation, and not as a measure of police, and troops should march with all military precautions, keeping up communication with their base in case of reverses. Secrecy and rapidity of execution are the great objects to be striven after. A number of guides should be collected, and placed under the orders of an officer acquainted with the language of the country, and who marches with the advanced guard. The guides are to be retained for the whole duration of the expedition. If the village or localities to be disarmed are neared towards nightfall, it is best to halt in a covered position with proper military precautions, advancing early next morning to carry out the work. All the approaches to the place are to be occupied by picquets, and a reserve is to be kept in hand in event of any resistance taking place. Usually the headmen of the locality will be summoned to surrender their arms, and a short interval allowed for this to take place, after which a systematic search will be conducted by parties going from house to house, keeping up communication to the rear, and paying no attention to the protestations of the inhabitants. The return march, with the arms on requisitioned wagons, is conducted in the same way as the advance.

In a paper on "General Considerations on Modern Warfare," Colonel Gammel sums up the recent changes in tactics and fire-discipline; advocating a steady, constant, and quick advance, when within the zone of aimed fire, as preferable to the slower advance by rushes, which has the disadvantage of drawing the enemy's concentrated fire on that portion of the chain making the forward movement. Entrenchments with several tiers of fire will form a prominent feature in future defensive battles; but the idea is no new one, as a square firing with three or four ranks to resist cavalry is the original idea of this species of fortification. As to the giving of orders, the Colonel's remarks are well worth quotation. He says:—"In war, clearness, simplicity, and correct and unhesitating orders are most important factors in troop-leading. A consistent and well-thought-out order will usually be a mean between an indecisive one, which permits of unimportant local circumstances exercising an influence over it, and a peremptory command which, arising from a headstrong vanity and over-estimation of one's own powers, forbids any modification whatever, as derogatory to one's strength of character. If a plan has been formed, after careful consideration of all circumstances, the staff officers concerned must be initiated into it; they must keep the main idea before their minds in every stage of the operation, and adapt their movements so as to lead to its attainment with due regard to local circumstances." Colonel Gammel quotes Macmahon's pilgrimage from Chalons to Sedan, in 1870, as a melancholy instance of the consequences of not keeping one object and one only in view. With respect to the vexed question of breadth

versus depth of infantry formation, the author unhesitatingly gives his opinion in favour of the latter, urging that each section of the fighting line should be complete in itself—*e.g.*, that one battalion should form skirmishers, supports, and reserve; the latter under the hand of the Colonel, who can turn it to any purpose the circumstances of the fight necessitate—such as prolonging the chain to a flank, or warding off a flank attack. He quotes Spicheren as an example of all the companies of battalions being thrown into the fighting line as chain and supports, without keeping a reserve, and argues that if any one of the divisions of Bazaine's corps had been moved up to assist Frorsard that day, a serious German reverse would have marked the 6th of August.

A paper by Major von Marnegg on the desirability of teaching the War Game—unhappily so little practised among ourselves—in military schools, and a translation of a collection of Turkish documents on the last war, close a very interesting number.

NOTICES.

Will the author of an MS. Essay, with the Motto "*Fine caret progressio—opertet mutare, &c., &c.,*" be good enough to communicate confidentially with the Secretary?

In consequence of the numerous enquiries addressed to the Secretary as to the books required for the examination for promotion from the rank of Captain to that of Major, the following list is published for general information:—

Gorham's Military Law.
Instructions in Military Engineering; vol. I., part I., sects. 13 - 14.
Col. Schaw, Attack and Defence of Positions, chaps. 5, 7, 8, & 9.
Clery's Minor Tactics.
Home's Tactics.
Instructions in Duties of Military Reconnoitring.
The forthcoming Manual of Military Topography.

In addition to the foregoing books, Captains will be expected to be acquainted with the contents of the usual Official Books shewn at Inspections, in so far as they are concerned with the subjects of the examination, and also with the Army Discipline Act. The regulations for the Examination are contained in G. O., No. 130 of 1st October, 1880.

ADMIRALTY,
November 23, 1859.

SIR,

With reference to your letter of the 19th inst., requesting on the part of the Committee of the Royal Artillery Institution that boxes or parcels addressed to the Institution may be forwarded by Government vessels, I am commanded by my Lords Commissioners of the Admiralty to acquaint you, that the Commanders-in-Chief on all the Foreign Stations have been directed to comply with this request as far as possible without inconvenience.

I am, &c.,
(Signed) W. G. ROMAINE.

Maj.-Gen. Sir R. Dacres, K.C.B.
Woolwich.

*** *To avoid loss of time, business letters should be addressed to the "Secretary," and* NOT *to "Major Hime."*

H. W. L. H.

SMITHSONIAN INSTITUTION LIBRARIES
3 9088 01219 3835